Human investment and the new economy in the European Union

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Abstract

The Lisbon Strategy gave a central role to human investment in the realisation of the objective for the European Union to become the most competitive and dynamic knowledge-based economic area with social inclusion in the world. Moreover, the Lisbon process introduced the Open Method of Coordination (OMC) intended to facilitate policy learning between member states in a number of areas of public policy, including human investment, by means of benchmarking and establishment of best practice. This raises a pressing question for European policy makers: How do we conceptualise and operationalise human investment for the purposes of the OMC and the Lisbon process? It is to this question that the thesis attempts to provide an answer. In so doing, the thesis develops a conceptualisation of human investment that takes account of the changing nature of human investment provision occurring as part of the wider socio-economic changes of the New Economy. The changing nature of human investment is captured in a framework of lifelong learning, with a number of new dimensions to human investment provision. On the basis of the conceptual framework, a number of variables are specified. After having taken stock of available data sources, statistical indicators are, in as far as possible, identified for each of the specified variables. The thesis then goes on to explore the picture of human investment provision in the European Union emerging from these indicators, with particular emphasis on how this picture differs from the findings arrived at from more traditional indicators of human investment. The thesis concludes by discussing the implications of the study for the measurement and analysis of human investment. In addition, the thesis explores wider implications for the use of benchmarking as a tool in economic and social policy, the OMC and the Lisbon Strategy.

Chapter 1
Introduction

"The European Union is confronted with a quantum shift resulting from globalisation and the challenges of a new knowledge-driven economy. These changes are affecting every aspect of people's lives and require a radical transformation of the European economy. The Union must shape these changes in a manner consistent with its values and concepts of society and also with a view to the forthcoming enlargement"

Presidency Conclusions, Lisbon European Council

The last decade has seen fundamental changes in the thinking underpinning social and economic policy-making. Pressures from growing economic and financial internationalisation and the transformation towards post-industrialisation has led analysts to scrutinise and question the viability of existing institutional frameworks and policy regimes. It has thus been argued that the increased financial and economic integration has led to a shift in policy priorities, with macroeconomic stability and balancing a country's external financial position increasingly taking precedence over other objectives such as full employment and social protection (Ferrera et al, 2000). Hence, "Unemployment problems and the need for modernisation of social protection systems should, on the whole, be attributed to the 'post-industrialisation' of advanced economies to which globalization may make some contribution but cannot on its own explain" (Ferrera et al, 2000:9-10). It has been argued that this process of change is driven by a transition towards a New Economy, with information and communication technologies reshaping industrialised economies and societies. More specifically, it has been suggested that the New Economy is characterised by a greater role for intangible capital such as knowledge and information, where economies previously were more biased towards tangible physical capital and energy-intensive production (Freeman and Soete, 1994).

This transition process has brought about new challenges to policymakers across the industrialised world. The introduction of the new technologies in the production

processes is rendering some existing low skill jobs obsolete, whilst creating a greater demand for highly skilled workers. In particular, the low skill jobs in manufacturing are disappearing, while the service sector is becoming increasingly polarised between high skilled well earning jobs and low skilled lowly paid jobs. Coupled with the constraints imposed by globalisation on governments' ability to respond to this change, the transformation in the labour market has resulted in what Ferrera et al (2000) calls the 'service sector trilemma'. According to their argument, "the goals of employment growth, wage equality and budgetary constraint come increasingly into conflict. Creating private sector employment entails lower wage and non-wage costs, risking greater inequality while generating such employment in the public sector is constrained by budgetary limits" (Ferrera et al, 2000:12). Consequently, the objectives of social and economic policies have changed in order for policy making to adjust to the current and future economic and social realities and challenges. Rather than focus on the establishment of a just distribution of income through taxation and social security transfers, the "pressing challenge for policy is [...] twofold: to up-skill low skilled groups through extended schooling, vocational training and education, in particular with the view that life long learning is becoming vital if citizens wish to participate as full members of the knowledge and information society; and second, engage in a concerted policy effort to increase job opportunities for low skilled groups who, for whatever reason, continue to lack marketable skills" (Ferrera et al, 2000:12).

1.1 New objectives

Within the EU, the initial response to these two challenges has been set out in the Lisbon strategy, developed at the Lisbon summit on economic reform, employment and social cohesion. It was agreed that the new strategic goal of the European Union for the next decade should be *"to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion"* (Lisbon European Council, 2000:5). This overall objective is to be achieved through a strategy build around the following three points (Lisbon European Council, 2000:2):

- Preparing the transition to the knowledge-based economy and society by better policies for the information society and R&D, as well as by stepping up the process of structural reform for competitiveness and innovation and by completing the internal market.

- Modernising the European social model, investing in people and combating social exclusion.

- Sustaining the healthy economic outlook and favourable growth prospects by applying an appropriate macro-economic policy mix.

It is suggested that successful implementation of such a strategy will result in a sustainable economic growth rate of 3%, whilst not compromising the social objectives of the European Union.

A central part of achieving both the economic and social objectives of the Lisbon Strategy is the emphasis placed on increased human investment. As the Lisbon European Council (2000:7) states: "Investing in people and developing an active and dynamic welfare state will be crucial both to Europe's place in the knowledge economy and for ensuring that the emergence of this new economy does not compound the existing social problems of unemployment, social exclusion and poverty". In recognition of an increased role for learning in the knowledge and information economy and society, it was agreed that the next ten years were to see a substantial increase in the per capita investment in human resources across the European Union. However, it has been stressed that it is not only a question of increasing the quantity of human investment, but also of changing the way in which human investment is provided to people, and at what times during a lifetime an individual can receive education, training and learning opportunities. "Europe's education and training systems need to adapt both to the demands of the knowledge society and to the need for an improved level and quality of employment. They will have to offer learning and training opportunities tailored to target groups at

different stages of their lives: young people, unemployed adults and those in employment who are at risk of seeing their skills overtaken by rapid change" (Lisbon European Council, 2000:7).

As part of the development of the Lisbon Strategy, there has therefore been an attempt to redesign the provision of education and training within the EU area, to achieve a provision of human investment that is more suitable to the requirements of the New Economy. Central to this transformation has been the development of strategies for lifelong learning. In the European Employment Strategy and the subsequent work by the European Commission, the working definition of lifelong learning is "all purposeful learning activity, undertaken on an ongoing basis with the aim of improving knowledge, skills and competence" (European Commission, 2000a:3). Lifelong learning should not be understood as merely an addition to existing objectives within education policy, but should rather be regarded as a paradigmatic shift in the approach to human investment within the European Union. "Lifelong learning is no longer just one aspect of education and training; it must become the guiding principle for provision and participation across the full continuum of learning contexts" (European Commission, 2000a:3). More specifically, there are six key requirements that have been highlighted as necessary for successfully putting lifelong learning into practice:

- "guarantee universal and continuing access to learning for gaining and renewing the skills needed for sustained participation in the knowledge society;

- visibly raise levels of investment in human resources in order to place priority on Europe's most important asset – its people;

- develop effective teaching and learning methods and contexts for the continuum of lifelong and lifewide learning;

- significantly improve the ways in which learning participation and outcomes are understood and appreciated, particularly non-formal and informal learning;

- ensure that everyone can easily access good quality information and advice about learning opportunities throughout Europe and throughout their lives;

- provide lifelong learning opportunities as close to learners as possible, in their own communities and supported through ICT-based facilities wherever appropriate."

(European Commission, 2000:4)

This change in approach to education and training involves the recognition that the emergence of ICT and the New Economy sets new challenges for people to gain new and update existing skills and knowledge throughout their lives, whilst also providing possible solutions to meet these challenges. A crucial part of the transformation of the European education and training systems towards facilitating lifelong learning is thus the emphasis placed on the application and utilisation of ICT for human investment purposes, as is evident in the e-Learning Action Plan by the European Commission (2001). In particular, the application of ICT to human investment provision increases the opportunities for education, training and learning to take place outside the traditional formal institutions of education. This has led to increased emphasis on the less formal ways of learning as central parts of the European human investment strategy. There are thus three different categories of purposeful learning activity that policymakers should pay attention to, rather than merely focus on the traditional formal provision of education and training.

- "**Formal learning** takes place in education and training institutions, leading to recognised diplomas and qualifications.
- **Non-formal learning** takes place alongside the mainstream systems of education and training and does not typically lead to formalised certificates. Non-formal learning may be provided in the workplace and through the activities of civil society organisations and groups (such as youth organisations, trades unions and political parties). It can also be provided through organisations or services that have been set

up to complement formal systems (such as arts, music and sports classes or private tutoring to prepare for examinations).

- **Informal learning** is a natural accompaniment to everyday life. Unlike formal and non-formal learning, informal learning is not necessarily intentional learning, and so may well not be recognised even by individuals themselves as contributing to their knowledge and skills."

(European Commission, 2000a:8)

At the political level there is thus an increasing awareness of the processes of transformation to human investment provision associated with the emergence of the New Economy.

1.2 Achieving the objectives

In addition to setting out the new aims for the European Union, the Lisbon Strategy also put greater emphasis on a framework, known as the Open Method of Coordination (OMC), for developing and assessing policies for the realisation of the social and political objectives. This new approach to public policy involves the following four points:

- "fixing guidelines for the Union combined with specific timetables for achieving the goals which they set in the short, medium and long terms;
- establishing, where appropriate, quantitative and qualitative indicators and benchmarks against the best in the world and tailored to the needs of different Member States and sectors as a means of comparing best practice;
- translating these European guidelines into national and regional policies by setting specific targets and adopting measures, taking into account national and regional differences;
- periodic monitoring, evaluation and peer review organised as mutual learning processes"

(Lisbon European Council, 2000:10)

It is argued that such a new framework will be a "means of spreading best practice and achieving greater convergence towards the main EU goals" (Lisbon European Council, 2000:10). Instead of implementing the same policies throughout the European Union, the OMC stresses the importance of individual member states setting their own policies. However, a member state can make use of the information, knowledge and experiences gathered through the OMC as tools when formulating and implementing a particular policy. The mechanisms of the OMC are thus intended to facilitate processes of learning between countries in a number of different areas of public policy. This is related to a wider strategy of facilitating policy learning between member states of the European Union, which grew out of efforts to coordinate policies in the area of the European Monetary Union and European Employment Strategy (De La Porte et al, 2001). The introduction of the OMC should therefore more be seen as an extension of existing practices applied to new areas of public policy, and the meeting in Lisbon should more be seen as "a focal point for bringing together existing (yet scattered) policy practices in a new discourse [...] than 'day one' of the new method" (Radaelli, 2003:17). It should also be noted that different policy areas had experienced different degrees of co-ordination at a European Union level. For example, and of particular relevance to this project, the area of education had not been subject to policy co-ordination in the European Union prior to the Lisbon Strategy. In this way, the introduction of the OMC allows for a degree of coordination within the European Union in areas that have previously been considered in the sole domain of the nation state.

As part of this process, the role of the European Commission is also transformed. As Dehousse (2002:11) notes "the search for cognitive convergence, which is at the heart of the OMC, involves tasks the Commission is better able to accomplish than any other institution, such as the monitoring of national action plans or the preparation of reports on the situation at European level, which are key elements in a process of knowledge accumulation. The Commission's central place in the Community machinery makes it a reference point that cannot often be overlooked, particularly in fields with weakly structured trans-national networks". Rather than playing the role of enforcer of harmonised standards across the EU, the role envisaged for the European Commission in

the OMC is thus one of coordinator, "organizing the exchange of best practices, presenting proposals on potential indicators, and providing support to the processes of implementation and peer review" (De La Porte et al, 2001:293). The guidelines emerging from the OMC do therefore not have a binding character, and the expectation is for a considerable degree of "emulation between the Member States" (notes from the Portuguese Presidency 12/1, 2000:point 6) to facilitate the success of the new strategy, instead of classical community control (Dehousse, 2002).

Accordingly, "In many respects, the open method of coordination is therefore presented as a third way between 'pure integration' and the logic of genuine intergovernmental cooperation. More open and less rigid than the former, the OMC is also more ambitious and better structured than the latter" (Dehousse, 2002:4). Hence the OMC is seen as an alternative to the traditional legislative procedures, as a way of conducting policy making for the European Union. As a result, the OMC is often referred to as 'soft law'. Furthermore, the OMC being a 'softer' approach to EU policy making is reflected in the emphasis placed on achieving coordination rather than harmonisation across the European Union.

However, the more flexible objective of coordination of policies has a number of implications for the scope and nature of the OMC and the role of benchmarks therein. Indeed, it is important to be aware of the risks of benchmarking and other processes of policy learning ending up as covert processes of harmonisation. Concerns about the nature and implications of the OMC have thus been voiced in a number of analysis, which note that the successful use of benchmarking requires some degree of consensus on the objectives to be achieved (De La Porte, Pochet and Room, 2001 and Lundvall and Tomlinson, 2001). When expanding the scope of policy learning and coordination into areas which are characterised by structural differences and varied national traditions, it may be more difficult to reach agreement on a common set of objectives and frameworks for comparison. If the particular area of policymaking is characterised by substantial structural differences, or differences in political priorities, traditional benchmarking may become a meaningless tool for policymaking, because the indicators provide little

information of relevance to where policymakers can intervene or of whether the objectives they have set out are being met. If the OMC is to succeed as a mechanism for policymaking within the EU, due consideration is therefore required of the opportunities for and limitations of benchmarks as a tool for policy learning. Accordingly, De La Porte et al (2001) goes on to suggest a different form of coordination which may accommodate differences in objectives and national traditions whilst still allow for policy learning to take place. A 'bottom-up' approach to benchmarking would allow countries to specify their own benchmarks, taking account of institutional features and national objectives and traditions, for which they think it is appropriate to be measured against other member states. "This would exploit the value of benchmarking as a tool for raising standards of performance, while at the same time recognizing the diversity of national policy objectives" (De La Porte et al, 2001:299). In such bottom-up benchmarking the European Commission "could play a technical role in ensuring that the member states had available to them information about best practice in each other's territories; and they could ensure that these information resources were organized in an efficient manner to avoid duplication of effort. Finally, the Commission could offer expert commentary on the national reports and facilitate peer review" (De La Porte et al, 2001:299). Hence, the nature of the OMC, and the role of benchmarks and the European Commission therein, may well have to adapt when applied to different areas of public policy.

In sum, the agreement of the Lisbon Strategy marks a significant change in human investment policy for the European Union. It is the first attempt to co-ordinate human investment policies for the member states, and does so by means of a new policy tool. However, the new objectives and the OMC set new challenges for policymakers. More specifically, in order to meet the human investment objectives through the mechanisms of the OMC, policymakers require a degree of common understanding of the challenges and opportunities associated with the changing economic and social conditions, and the relevant information to guide them in their efforts to meet these challenges and realise the opportunities. A central objective of the OMC is thus to achieve 'cognitive convergence' where "Emphasis is placed on developing common interpretations of situations, common values and techniques, through an iterative learning process. Discussions about common

objectives and the analysis of national policies are expected to lead to a mutual sharing of knowledge" (Dehousse, 2002:10). Hence, a central part of the implementation of the Lisbon Strategy is the development of data and indicators for human investment that take account of the conceptual and methodological challenges brought about by the emergence of the New Economy. It is thus recognised that there is a pressing need to ascertain the relevance and conceptual resonance of existing social and economic indicators, and assess whether new indicators are required for the era of the New Economy, and if so what these indicators might be.

It is from these objectives and processes of the Lisbon Strategy that the New Economy Statistical Information System (NESIS) project, of which this thesis is part, derives its purpose. The key objectives of the NESIS project are to "ascertain more fully the policy needs for indicators on the new information economy and better to understand the methodologies by which the Commission have produced and measured them [and] Conceptually and statistically to contribute to the appraisal of existing EU benchmarking indicators" (NESIS project summary:2). In meeting these objectives it is hoped that the NESIS project will allow for the identification of the areas for which the European Statistical System need to respond in order to meet the challenges of designing appropriate indicators for the New Economy. Taking its cue from the objectives of the Lisbon Strategy, the NESIS project has four main pillars. These are as follows:

- Macroeconomic stability and environmental sustainability
- Productivity and growth
- Human investment
- Social Inclusion

These four pillars outline the main areas in need of conceptualisation and operationalisation for the purposes of the Lisbon Strategy. Accordingly, the NESIS project has been set up to conceptualise the implications of the emerging New Economy, and take stock of and appraise the available data and indicators, for each of the four pillars. Where no satisfactory data is available, it is the aim of the NESIS project to be

able to recommend courses of action for the European Statistical System, which will allow for the construction of suitable indicators.

With the new challenges for policymakers and the NESIS project as context, this research project will focus on pillar 3 of the NESIS project and attempt to answer the following question:

How do we conceptualise and operationalise human investment in the era of the New Economy?

In order to answer this question the project will first explain how the emergence of the New Economy challenges our understanding of human investment. The focus of this analysis will be on changes to the demand for and supply of human investment arising from the economic and social transformations associated with the New Economy. This analysis will result in the development of a conceptual framework that takes account of the new dimensions of human investment arising with the emergence of the New Economy. Subsequently, the operationalisation of the conceptual framework will be based on a specification of variables and stocktaking of available data sources. From these efforts, the objective is to develop a set of statistical indicators that resonate with the conceptual framework. The picture of human investment provision in the EU emerging from these indicators will then be explored, such as to ascertain the relevance of the new indicators for benchmarking human investment for the purposes of the OMC and Lisbon Strategy.

Finally, it should be noted that the Lisbon Strategy and the OMC have been met with a substantial amount of scepticism, some of which has been discussed above. In particular, the extent to which the objectives of the Lisbon Strategy are realistic and the emphasis on human investment as the means by which to achieve them have been questioned. However, while the Lisbon Strategy and the OMC raises a number of substantive questions as to their appropriateness, it is important to stress that it is not the objective of this project to answer any of these questions. Rather, the view taken in this project is that

in order to answer any of these questions it is first necessary to reach an appropriate conceptualisation and operationalisation of human investment provision in the European Union. Accordingly, it is hoped that the work undertaken in this project will provide some of the necessary tools by means of which the more substantive questions about the Lisbon Strategy and role of human investment for achieving the economic and social objectives can be answered.

Chapter 2

Literature Review

2.1 Introduction

The literature on human investment is vast and riddled with controversy. The objective of this literature review is to cover the key discussions on human investment and its interaction with the wider socio-economic setting. This review will focus on the key literature that explores the processes of human investment and the role of human investment and capital for achieving economic objectives. In addition, the review will highlight some of the empirical investigations that have been conducted on the contribution of human investment and capital to economic growth, and the indicators currently utilised for measuring human investment and capital.

2.2 Review

That human beings are crucial to the processes and activities that make up the economic system is almost self-evident and has long been acknowledged in the social science literature. However, the exact nature of the contribution made by people to the economy, and, in particular, the role of human beings in the production process, has remained contested issues.

The initial theoretical articulation of human beings as factors of production goes as far back as Adam Smith (1776) and the classical tradition in economics. He argued that human skills are contributing factors to the wealth, not only of the individual, but also of society as a whole, and therefore included the inhabitants' acquired and useful talents in a nation's capital stock. However, classical economics treated human skills and knowledge as an entity embodied in the labour force, rather than as a produced means of production in which one could invest and accumulate.

Subsequently, as classical economics gave way to neo-classical economics, the notion that human beings are a factor of production, seemed to have disappeared from mainstream economic thinking. Economists focused their attention on investment in physical capital, while expenditure on education and training was viewed as consumption goods. Indeed, in most national accounts, expenditure on education and training is still accounted for as national consumption rather than investment.

However, human capital as an economic concept was introduced to the neo-classical school of thought by Schultz (1961) and Becker (1964), and has since gained significance in the neo-classical economic literature. While Becker conducted the initial attempts at modelling the human investment decisions of actors in the economy, Schultz analysed the role of investment in human capital for economic growth. While Becker thus developed the microeconomics of education, Schultz explored the macroeconomic impacts of investment in human capital. Schultz argued that the failure of neo-classical economics to explain the significant changes in growth patterns between different countries, was in large part due to its reluctance to acknowledge that "skills and knowledge are a form of capital, that this capital is in substantial part a product of deliberate investment, that it has grown in Western societies at a much faster rate than conventional (nonhuman) capital, and that its growth may well be the most distinctive feature of the economic system" (Schultz, 1961:13).

2.2.1 The microeconomics of human Investment

The work of Becker spurred a vast range of work on the microeconomics of human capital that examined the factors that shape individuals' human capital formation decisions. A significant distinction has been drawn between primary and secondary education and other forms of human investment, because the former type is characterised by decisions being taken on behalf of the investing agent by educational institutions or parents. Consequently, the focus in the analysis of primary and secondary education is on the factors that impinge on the decisions of parents and other stakeholders in the child's education. Human investment decisions will therefore not necessarily be made in the sole interest of the child, but also take into consideration the needs and interests of the family or society as a whole. A key concern has therefore been the constraints imposed and opportunities granted by family, community and educational institutions to a child's education. Becker, Murphy, and Tamura (1990) noted that human capital abundant societies experienced high returns on human investment relative to the gains of having more children, while societies in which human capital is scarcer the return of having more children increases relative to the return on human investment. This would explain why "societies with limited human capital choose large families and invest little in each member; those with abundant human capital do the opposite" (Becker, Murphy, and

Tamura, 1990:35). This is for example reflected in the comparatively long compulsory education that children must go through and the extensive legislation prohibiting child labour seen in industrialised countries.

Furthermore, it has been argued that as parental income increases so the opportunity cost of education expenditures is reduced, and as a result the quantity of human investment is greater (David, 2001). Lee and Barro (1997) find that not only the quantity but also the quality of education increase with parental income.

Looking beyond the immediate family, Borjas (1995) has argued that the ethnic environment plays a significant role in shaping the educational environment for children. The "ethnic spillover implies that the skills of ethnic children depend not only on parental skills, but also on the mean skills of the ethnic group in the parents' generation" (Borjas, 1995:388). The importance of ethnicity for a child's education is further highlighted by Cutler and Glaeser (1997) in their examination of the significance of role models, and Tomes (1985) who found that religion significantly influenced a child's education.

The analysis of human investment other than primary and secondary education has predominantly been concerned with the influences that shape an individual's decision whether to invest or refrain from investing in human capital. Much of the work has therefore focussed on the returns to an individual from human investment, and potential constraints facing an individual when making those decisions. The pioneering work in this field was conducted by Mincer (1962, 1974) who examined inter-temporal trade-offs for individuals between entering the labour market now or investing time and money in additional education. This has led to several estimates of the return to higher education in many industrialised countries based on what has come to be known as Mincer earnings regressions. The findings of these studies show that the "evidence that earnings are positively associated with schooling is robust and uncontroversial" (Temple, 2000:9).

Nevertheless, while the positive relationship between schooling and potential earnings is unquestionable, a question-mark remains over the role of education in enhancing an individual's productivity. Mincer regressions assume perfectly competitive labour markets in which wage differentials are attributable to differences in marginal productivity, and that the positive relationship between schooling and earnings imply that differences in productivity are due to differences in schooling. However, it has

been questioned whether it is the schooling that is the cause of the higher earnings, or if the level of schooling is closely correlated with other attributes that are the real causes of the wage differentials. More specifically, Spence (1973) suggested that schooling works as a signalling mechanism to the labour market regarding an individuals abilities, and that it is this signalling mechanism rather than the contribution of skills and abilities that is the cause of the positive relationship between levels of schooling and earnings. This argument has been further developed by Weiss (1995) and raises serious doubts over whether the empirical results from labour economics can be used as supporting evidence for the suggestion that education contributes to productivity through an improved quality of the labour force.

The analysis of possible constraints on an individual's decision to invest in human capital have predominantly looked at various market failures that result in sub-optimal allocation of resources towards human investment provision. These market failures can be grouped in to three different categories. Firstly, the funding of an individual's human investment may be limited by imperfections in the capital markets. Such borrowing constraints may play a significant role in reducing the amount of human investment available to individuals (David, 2001).

Secondly, there may well be benefits arising from human investment that are not appropriated by the economic agent carrying the cost of the decision to invest. In other words, the market mechanisms lead to a sub-optimal allocation of resources towards education and training because of externalities.

Thirdly, there are significant time lags between making the human investment decision, and the period during which the return on the investment is appropriated. Consequently, there is insufficient information available about the future labour market and demand for the skills and qualifications that individuals decide to gain at any given moment. As a result, "current decisions are to a large extent driven by current payoffs to different *levels* and *types* of education but these investments involve a long gestation period, and the occupational wage structure can be quite different by the time the people conclude their courses of higher education and vocational training and enter the labour market. This uncertainty results in the loss of resources devoted to cognitive skills that are not required or fully used; clearly, this implies a payoff for 'broad' educational investments in skills that can be used in many occupations" (David, 2001:45).

All three categories of market failures imply that there may be a crucial role to be played by government intervention in the provision of human investment. This is not to say that public provision of education is necessarily a more efficient allocation of resources than delivering education and training via the market, but that government should in as far as possible attempt to realign the incentives of economic agents such that the optimal decisions of private agents converge with the allocation of resources that is socially optimal.

An additional issue that has been increasingly explored in recent years has been the relationship between the education received at primary and secondary level and subsequent further education or on-the-job training. The human capital accumulated during primary and secondary education may in many cases be essential for the further investment in human capital. Furthermore, the primary and secondary education works as a signal to firms about the employee's ability and willingness to learn, increasing the willingness of the employer to provide more training. In a study of the US, Mincer (1997) thus finds a positive relationship between the level of formal schooling received by an individual and investment in on-the-job training.

The utilisation and access to post-compulsory education and training becomes of particular relevance during periods of rapid technological change. An acceleration of the pace of technological progress, such as that expected to be a central feature of the New Economy, requires employees to update their human capital throughout their working lives. Consequently, the positive relationship between the initial formal education and subsequent access to further training becomes of central concern to policymakers' human investment strategy. Hence, the justification for investment in primary and secondary education is rooted not only in its direct economic returns, but also indirectly through its complementary effect on subsequent human investment efforts.

Furthermore, a central issue in the microeconomics of human investment has been how the cost and benefits of human investment is distributed amongst the various stakeholders in society that are affected by an individual's decision to invest in human capital (David, 2001).

Much attention has been paid to the training provided to employees while they are on the job. Here the central issue has been the extent to which employers or employees are carrying the cost of training.

In order to conduct an analysis of this issue in greater depth, it has been necessary to introduce a more heterogonous conceptualisation of human investment. Accordingly, the literature has drawn a distinction between the training that yields generic skills with a wide applicability and the training that gives the employee skills that are specific to the firm and particular job that the employee is expected to perform (Becker, 1964). The human capital theory developed by Becker makes it clear that employers are unlikely to finance any training for generic skills or the provision of skills that can relatively easily be transferred to other firms. Given the ease with which these skills can be transferred to a different firm, it is likely that the employee will switch to a different firm and gain a wage premium on the basis of his or her new skills. Consequently, the funding of training for generic or transferable skills will most likely be financed by the employee directly or indirectly by a salary that is less than the employees marginal product. In contrast, skills that are specific for the firm may well be worth investing in for the firm, because they will be able to appropriate the ensuing productivity gains (Hashimoto, 1981).

It is evident from the review of the literature on the microeconomics of human investment, that one of the key problems facing policymakers is that of correcting various market failures such as to reconcile the incentives facing the individual economic agent with the interests of society as a whole. In order to know the extent to which interventions are required it is necessary to know how important human investment is for economic growth. However, as noted above, the estimates that can be conducted at the micro-level of the contribution of human capital to productivity rest on the assumption that schooling contribute to an individual's skills and abilities. In addition, the empirical estimates conducted at micro-level such as Mincer regressions assume that the productivity gains of human investment are entirely appropriated by the employee through higher wages. It is therefore debatable whether analysis conducted at the micro-level can provide all the necessary information to guide policymakers' decisions. Consequently, economists have increasingly turned their attention to the macroeconomics of human capital and economic growth. The

next section will review some of the most important contributions to this area of the economics literature.

2.2.2 The macroeconomics of human investment

The introduction of human capital into the macroeconomic growth literature was a response to the perceived failings of the existing neo-classical growth models to explain some of the critical features of long-term economic growth. In order to contextualise the analysis of human capital and economic growth it is therefore helpful to briefly review the macroeconomic literature on economic growth.

The initial attempts to explain long term economic growth in a neoclassical framework, developed by Solow (1956) and Swan (1956), showed that economic growth would eventually come to an end as a result of diminishing returns if technological progress did not take place. However, a crucial weakness in these initial attempts to model long run economic growth was that they failed to explain how and why this technological progress took place. The key parameter affecting the growth rate in the long run was thus exogenous to the model. Neo-Schumpeterian endogenous growth theory has emerged from the recognition that the processes of technological progress are shaped by the dynamics of capitalist economies, and that a theory of long run economic growth needs to be able to explain why and how technology changes over time. In other words, the technology parameter needs to be an endogenous variable in the model.

Although it is difficult to map out a wide-ranging literature into a few categories, it is helpful to distinguish the attempts to endogenise the technology parameter into two different approaches. One approach plays particular attention to the role of capital accumulation (both physical and human) in promoting the development and diffusion of new technologies, while the other approach emphasises the role of innovation. As will be shown in the following each of these approaches lead to very different conclusions about the role of human capital for long-term economic growth.

The role of capital accumulation in explaining the changes in the technology parameter has been brought to the attention of growth theorists by Arrow (1962) who thought of technological progress as the unintended result of the experience of producing new capital goods. This process of 'learning by doing' will allow

technological progress to take place as a result of saving and investment. Along similar lines, Kaldor (1957) argues that investment in new vintages of capital goods is crucial for the implementation of new ideas. Long run economic growth then becomes related to the rate of investment, which in turn will reflect the underlying rate of new ideas and how prepared a society is to adapt to these new ideas. Thinking of the technology parameter as growing in proportion to capital is often referred to as the AK approach to endogenous growth. It was further developed by Romer (1986) who developed a model in which the diminishing returns to capital experienced by private firms are offset by the external improvements in technology that capital accumulation brings about.

Taking the analysis further, Uzawa (1965) and Lucas (1988) have highlighted the role of human capital in achieving sustained economic growth. In his seminal contribution to the endogenous growth literature, Lucas argues that accumulation of human capital can be an alternative source of sustained growth, implying that technological progress is embodied within the process of accumulating physical and human capital. Following Becker's work on human capital accumulation, Lucas (1988) argues that the investment decisions of economic agents with regard to human capital are the key determinants of differences in economic growth between countries. As with Becker's microeconomic model of human capital, Lucas develops a growth model in which individuals can allocate their time between current production and skill acquisition, where the latter increases the productivity of the former in future periods. Assuming constant returns to human capital accumulation, Lucas' model arrives at a positive long-run growth rate. This assumption, however, does not have much support from neither empirical evidence nor Becker's initial theory of human capital, which suggested decreasing returns to human capital over an individual's lifetime. Indeed, one of the key criticisms levied against Lucas' model has been his reliance on this rather unrealistic assumption of constant returns to human investment. In response, Lucas has argued that the constant returns to human investment is the result of a social feature of education and training that results in each generation inheriting some of human capital accumulated by previous generations. Acemoglu (1996) have developed a more formal demonstration of how constant or increasing returns to human investment may come about. Assuming that employees and firms make their investment decisions regarding human and physical capital, they are subsequently

randomly matched. The return to physical capital will depend on how much human capital will be available per unit of physical capital and vice versa for the return to human capital. Consequently, if the amount of human capital is increased the expected return to physical capital will increase and give firms an incentive to invest. The increased physical investment in turn leads to greater expected returns to human capital which will further induce investment in human capital and so on. The implication of Acemoglu's argument is that the investment decisions for physical and human capital are closely related and needs to be co-ordinated. Hence, there is the possibility of countries ending up in either high or low growth equilibrium trajectories, depending on the expectations of firms and employees about each other's levels of investment.

The second approach to endogenous technological progress emphasises the role of research activities in generating quality enhancing innovations that in turn lead to sustained growth. Segerstrom, Anant and Dinopoulos (1990) have modelled sustained growth as the outcome of continuous product innovation in a given number of sectors with no uncertainty in the process of innovation. In contrast, Aghion and Howitt (1988 and 1992) have modelled growth as the result of a random sequence of innovations, which in turn are the outcome of uncertain research activities. Hence, in this approach the key determinant of a society's long run economic growth is the allocation of resources between productive and innovative activities. This allocation of resources is determined by the returns to each activity, which implies that a key challenge to policy makers is to reconcile the socially optimal allocation with the incentives available to actors within the economy.

Analogous to the work by Uzawa (1965) and Lucas (1988) introducing human capital to the first approach, Nelson and Phelps (1966) has outlined a model that gives human capital a role in the innovative processes of the economy. The role for human capital is thus to enhance an individuals capacity to, firstly, innovate and, secondly, to adapt to new technologies and enhance the diffusion process of technological innovation. Hence, human capital is much more than merely another factor of production, and a crucial contributor to the technological progress of an economy. Where the Lucas approach assumes that new technology arise 'automatically' from the accumulation process of physical and human capital, the Nelson and Phelps approach is more explicit in outlining specific roles for human capital in the development and diffusion

of new technologies. Unlike physical capital, its human equivalent has an inherent ability to innovate and create improved products and production processes, whilst also playing a central role in enabling the diffusion of new products and processes to take place. It is this dual ability of human capital that ensures the long-run economic growth. Hence, in contrast to the conclusion reached by Lucas, the implication of the Nelson and Phelps approach is that it is the level of human capital rather than the rate of accumulation that is crucial for sustained long-run economic growth.

The two different approaches to endogenous growth with their concomitant roles for human capital serve to give great insight into the processes of technological innovation and long-run economic growth in capitalist economies. The second approach highlights the importance of allocating resources towards research activities, while the former approach stresses the importance of accumulating physical and human capital in order to apply and use the output of the research activities.

In addition, it is worth noting some more recent work that analyse the dynamic relationship between human capital and technological development. In particular, it has been highlighted how human capital and technological progress interacts to create trajectories of long-run economic growth. Where much of the growth literature assumes that technological progress is neutral in its impact on factors of production, the more recent work has explored the effects of introducing a more heterogenous conceptualisation of technological development that is non-neutral. Among the various factors of production, a new technology may thus work as a complement or substitute. A lot of empirical evidence seems to give support to this understanding of technological development. In nineteenth and early twentieth century Britain, technological developments were largely skill-replacing, i.e. they acted as substitutes for skilled labour. As Mokyr (1990, p.137) explained: "First in firearms, then in clocks, pumps, locks, mechanical reapers, typewriters, sewing machines, and eventually in engines and bicycles, interchangeable parts technology proved superior and replaced the skilled artisans working with chisel and file". Technology was thus a substitute for human capital. In contrast, Acemoglu (1998) examines the technological developments that have occurred over recent decades, with particular emphasis on the emergence of ICT, and argues that these technologies complement human capital, and may even have emerged as a response to the greater availability of human capital.

More specifically, Acemoglu looks at the increase in college graduates that emerged as the baby-boom generation entered the labour market from the 1970s onwards, and suggests that firms took account of this increase in human capital when they decided on their research activities. The availability and expectations of increased availability of human capital thus directed technological innovations towards complementing this particular factor of production, i.e. the technologies are skill-biased.

If a dominant technology is biased in favour of a particular factor of production, the relative prices and returns to the factors of production will change as technology progresses. This has interesting implications for the trajectories of long-run economic growth. When making decisions about research and development firms and entrepreneurs will look at the future availability and prices of the factors of production that are required for the appropriation of the return to the research efforts. As a result, the research efforts will respond to changes in the expectations about the rates of accumulation of the different factors of production. Consequently, the human investment decisions will shape the research efforts, whilst the research efforts in turn will determine the rate of return on the human investment efforts. "Thus, it is not enough that the firms know they are making R&D investments premised upon the future availability of the right kind of (complementary) capabilities in the workforce. The firms need to know that this is known and understood by the agents who must make the necessary forward-looking decisions as well, if those premises are to be fulfilled" (David, 2001:67).

Acemoglu (1998) shows how this dynamic relationship between research activities and investment decisions is complicated by the very long time lags associated with human investment decisions and the opportunities to appropriate a return on the investment. As noted in the section on the microeconomics of human capital, the time lags often results in many of the decisions regarding human investment being based on current returns rather than expectations about future technological change. Similarly, the results of research activities can take a very long period of time to materialise. If the match between the supply of skilled labour and the technological innovation required to provide a proper return on human investment efforts is missing, the result may be a different economic growth trajectory in which people refrain from investing any further in human capital, and the research activities are slowed down. This creates a potential problem for policy makers when attempting to

co-ordinate investment efforts to fit the research efforts that lead to the optimal long-run economic growth trajectory.

In particular, people's desire to invest in human capital is often affected by the seemingly perennial existence of skill-gaps and bottlenecks of various types in the labour market. Consequently, an important question to examine is whether these mismatches have not only periodical implications but also affect the trajectory of technological progress. If so, the ability of policy makers to co-ordinate research activities and the human investment efforts to avoid the existence of skill gaps and bottlenecks is critical in ensuring a trajectory of technological progress that ensures optimal long-run economic growth.

In sum, the literature on the macroeconomics of human capital highlights the various roles of human capital for growth, and provides possible explanations of the dynamic relationship between human capital, technological innovation and long-run economic growth. Taken as a whole, the literature illustrates potential risks and opportunities associated with the processes of human capital accumulation, and the issues that policymakers must be aware of to promote the optimal long-run growth trajectory of an economy. However, in order to use the insights of the theoretical work developed in the macroeconomics of human capital for policymaking purposes, it is essential to have empirical estimations of the contribution of human capital. It is to these empirical estimations that I shall now turn.

2.2.3 Empirical estimations of human capital investment's contribution to economic growth

Empirically, the growth models that assign a role to human capital has been analysed through two different methods; growth accounting and cross-country regression analysis. The former attempts to explain changes in output by reference to changes in the inputs of the economy. Any output change that cannot be explained by changes in inputs is due to a change in efficiency. Some of the principal contributors to the growth accounting analysis of human capital and economic growth have been Jorgenson, Gollop and Fraumeni (1987). They find that for the period 1948-1979 changes in labour input account for approximately a third of the growth in aggregate value added in the US. The estimate of labour inputs takes account of both quantity

and quality changes over the period. The improvement in labour quality is responsible for about a tenth of the growth in aggregate value added in the US economy over the period. However, as noted by Temple (2000), the estimate of labour quality takes account of several factors that may offset the contribution of improved educational attainment. The way the labour quality index has been constructed means that the entry of women and young people in to the labour market, in predominantly low-paying jobs, has a negative impact on the labour quality index. Consequently, the contribution of education to the growth in aggregate value added is underestimated by the labour quality index in the growth accounting exercise.

In a review of the growth accounting evidence for the US, Griliches (1997) concludes that the increase in educational attainment has contributed about a third of the US productivity residual in the post-WWII period, corresponding to 0.5 percentage points on the annual growth rate of aggregate output during the 1950s and 1960s and 0.2-0.3 percentage points during the 1970s.

The positive contribution of education to growth found for the US has been echoed in studies of other OECD countries. In growth accounting studies of six OECD countries Maddison (1987 and 1991) finds that changes in the labour quality added between 0.1 and 0.5 percentage points to annual growth rates between 1950 and 1984.

However, a problem with the growth accounting studies is their neglect of the indirect effects that human investment may have on economic growth. In particular, they fail to capture the potentially positive relationship between human capital and technological progress as argued in the Nelson and Phelps approach to human capital and growth. Another weakness lies in the estimation of the value of labour inputs which is based on two crucial assumptions as highlighted by Griliches (1997). Firstly, it is assumed that factor markets are perfectly competitive and that differences in rewards between workers correspond to differences in marginal productivity. Secondly, it is assumed that observed differences in market rewards for different schooling levels are due to productivity differences originating in the different levels of schooling. Both of these assumptions are highly contentious and weaken the results of the growth accounting studies. Consequently, Griliches (1997:S333) argues that "the main, and possibly only, approach to testing the productivity of schooling directly is to include it as a separate variable in an estimated production function". Economists have therefore increasingly turned to cross-country regression analysis as

a method of estimating the contribution of human capital to economic growth. The most important of these studies will be reviewed in the following.

In their growth analysis of OECD countries, Mankiw, Romer and Weil (1992) conduct a cross-country regression analysis based on an expanded neo-classical growth model that takes account of both physical and human investment. In essence, their approach is to expand the interpretation of capital to include human investment, but without attributing a role to human capital that is different from that of physical capital. Their findings suggest that these modifications to the neo-classical growth model are sufficient to explain much of the difference in long-run growth experienced between countries. Furthermore, their results show that if human investment as a share of GDP is increased by one tenth the output per worker should increase by approximately six percent. However, the Mankiw, Romer and Weil study has not been without its critics, and the support it gives to the neo-classical model of economic growth has been questioned by subsequent studies. In particular, the estimates have been shown to be very sensitive to the choice of variables that are included (Temple, 2000).

In an important study by Benhabib and Spiegel (1994) it is argued that an estimate of the contribution of human capital to economic growth has to be broken down into the roles of human capital as outlined in Nelson and Phelps approach. "As pointed out by Nelson and Phelps (1966), by treating human capital simply as another factor in growth accounting we may be misspecifying its role. [...] we introduce an alternative model which allows human capital levels to directly affect aggregate factor productivity through two channels: Following Romer (1990), we postulate that human capital may directly influence productivity by determining the capacity of nations to innovate new technologies suited to domestic production. Furthermore, we adapt the Nelson and Phelps (1966) model to allow human capital levels to affect the speed of technological catch-up and diffusion. We assume that the ability of a nation to adopt and implement new technology from abroad is a function of its domestic human capital stock. In our model, at every point in time there exists some country which is the world leader in technology. The speed with which nations 'catch up' to this leader country is then a function of their human capital stocks." (Benhabib and Spiegel, 1994:144-145)

Clearly, the estimation of Benhabib and Spiegel places great emphasis on the stock of human capital to explain differences in economic growth, whereas the Mankiw, Romer and Weil study focussed on the rates of accumulation of human capital. Their results suggest that the level of the human capital stock is a far more important determinant of economic growth than the rate of accumulation. Indeed, their findings suggest a very weak correlation between the change in educational attainment and economic growth; a result that is further supported by an empirical study of Pritchett (1996).

Of greater concern to economists who stipulate a significant role for human capital in advancing economic growth, more recent studies, such as that by Wolff (2000), cast doubt over whether investment in human capital brings about any significant productivity increases. From his regression analysis of OECD countries over the period 1950 to 1990, Wolff finds no statistically significant contribution of formal education to productivity growth, whether it is the rate of accumulation or the stock of human capital that is examined. This result clearly contradicts the predictions of both the micro and macroeconomics of human capital. However, a criticism that has been levied against Wolff's study as well as other cross-country regression analysis has been the poor quality of the indicators used. It is therefore worthwhile to explore the data and indicators that are being used for the macroeconomic analysis of human investment, capital and economic growth in greater detail.

2.2.4 Human investment and capital data

A crucial weakness of all empirical studies of the relationship between the level and changes in human capital and economic performance is the inadequacies of the utilised data for the explanatory variable. Fuente and Doménech (2000) argue that the inconsistencies in the results of the many studies that have been conducted on the contribution of investment in human capital to economic growth are at least in part due to the lack of good indicators for human investment and capital. More specifically, the efforts to develop indicators that capture the level and changes in human capital have been faced with the difficulties presented by the intangible nature of the variable the indicator is intended to proxy. Many dimensions of education and training are not easily quantified and it is therefore very difficult to develop statistical

indicators that resonate satisfactorily with a commonly agreed understanding of investment in human capital.

In various attempts to overcome the difficulties of measuring human investment and capital, a number of data sets have emerged. The data sets measure average years of schooling focusing on the formal provision of education as a proxy of human investment efforts to the neglect of more informal approaches to education and training. In general, the data sets have been constructed using either census data and enrolment rates or only the latter. If both are used, the census data will be the primary source of information, with enrolment rates used to fill in the gaps. If only enrolment rates are used, a time series will be constructed using a perpetual inventory approach. One of the most widely used data set based on census data and enrolment rates is that of Barro and Lee (1993 and 1996). In its most up to date version this data set covers the time span 1960-1990, and includes school quality measures such as pupil/teacher ratio, public educational expenditures per student and the length of the school year. Of the data sets based purely on enrolment rates one of the most sophisticated is that of Nehru, Swanson and Dubey (1995). Unlike many other data sets developed by the perpetual inventory method this set includes data prior to its 1960 starting point and thus relies less on backward extrapolation of enrolment rates, whilst also adjusting the data for repetition of grades and dropout levels.

The different methodologies for developing indicators of human capital and investment have given rise to great inconsistency in the measures and ranking of countries with regard to human capital stocks. As Fuente and Doménech (2000) argue: "Methodological differences across different studies would be of relatively little concern if they all gave us a consistent and reasonable picture of educational attainment levels across countries and their evolution over time. [However] this is not the case. Different sources show very significant variations in terms of relative positions of different countries. Although the various studies generally coincide when comparisons are made across broad regions (e.g. the OECD vs. LDCs in various geographical areas), the discrepancies are very important when we focus on the group of industrialized countries. Another cause for concern is that practically all available data on educational stocks and flows, including UNESCO's enrolment series, present anomalies which, to some extent, raise doubts about their accuracy and consistency. In particular, the schooling levels reported for some countries do not seem very

plausible, while others display extremely large changes in attainment levels over periods as short as five years (particularly at the secondary and tertiary levels) or extremely suspicious trends" (Fuente and Doménech, 2000:5). Accordingly, a number of problems persist in the empirical analysis of human capital investment.

However, the problems encountered in the empirical analysis of human capital investment and economic performance may be due to more fundamental problems in the theorisation of human capital investment and economic growth in the neo-classical economics literature. These problems have been highlighted in literature trying to provide an alternative approach to the analysis of processes of change in capitalist societies. This alternative approach to economic analysis is known as evolutionary economics.

2.2.5 Insights from evolutionary economics

Endogenous growth theory has provided economists with useful insights into the processes of technological progress and economic growth. The Neo-Schumpeterian Endogenous Growth literature works within a framework with two analytical dimensions: the individual economic agent (person or firm) and the market in which exchanges between the economic agents take place. As such, the literature has helped illuminate critical aspects of how market structures and actions of rational individual economic agents shape technological progress in modern economies.

However, the Schumpeterian approach to technological progress and economic growth has found a different interpretation in the evolutionary approach to economics. Pioneered by Nelson and Winter (1982), evolutionary economics argues that the assumptions on which the neo-classical economic tradition works, render this literature unable to explain the dynamics of technological progress sufficiently. In particular, the evolutionary economics literature grew out of a concern with two basic assumptions of the neo-classical economic paradigm: that firms literally maximise expected profit, and that the industry and economy as a whole are in (moving) equilibrium. The latter refers mainly to a lack of analysis of the processes that move the economy forward through technological progress. The emphasis on equilibrium makes the neo-classical economic framework very static and renders it unable to capture the dynamic nature of capitalist economies as described by Schumpeter. To some extent, the development of endogenous growth theory has attempted to deal

with this problem. However, the criticism of maximisation of expected profits goes to the heart of how economies are modelled in traditional growth economics on the basis of rational expectations. "The problem with the maximization assumption is not that it connotes a profit motive and intelligent effort to achieve profits, but that it connotes, as well, ability beyond human capabilities to perceive alternative courses of action and compare the consequences of exploring different parts of a previously unexplored terrain" (Nelson, 2000:50). Hence, the approach developed in endogenous growth theory still "takes the firm's choice sets as obvious to it and the best choice similarly clear and obvious. And because of that, the reasons for firm differences, in technology or organization, are ultimately driven back to differences in initial conditions, or to the luck of a draw, which may make choice sets different. Given the same conditions, all firms will do the same thing" (Nelson, 2000:107)

The evolutionary economics literature asks us to look more closely at the determinants of the behaviour of individual economic agents. In particular, the emphasis has been on the nature of organisations and how firms behave in an environment of continuous unpredictable change. To ascertain how behaviour is shaped within an evolutionary environment a more holistic analysis of the interactions between individual economic agents and the context in which they operate is required. Individual economic agents can thus not be expected to act in a uniformly optimal and rational manner. Rather, evolutionary economics argues that firms are boundedly rational entities acting in a changing environment of great complexity (Nelson and Winter, 1982; Simon, 1957; March, 1994).

2.2.5.1 Organisations in evolutionary economics

In an evolutionary environment the firm is in constant need to adapt to change and take account of new risks and opportunities. The way in which an organisation adapts to change is dependent on the experiences, competences and routines pervasive within the organisation. We would therefore expect to see different organisational forms, behaviours and performance between firms in the same industry. This suggests a degree of path-dependency for organisations, shaped by their existing competencies and experiences. The 'core competences' approach sees organisations as collections of resources, some of which are transferable while others are firm specific. The latter form the basis of differences between organisations and their long-term comparative

advantage (Wenerfelt, 1984 and Barney, 1986). Of particular interest when examining organisational differences are the core competences that have been build up over time through processes of learning and selection (Prahalad and Hamel, 1990).

However, this is not to suggest that the core competences of the organisation are the sole determinants of the evolutionary path of the organisational structure. Rather, firms within a given industry or sector operate within a given technological paradigm (Dosi, 1982) that shapes "'modal forms' of technological learning and 'modal types' of organizations suited for those learning patterns" (Dosi and Malerba, 1996:9). The organisation of firms and technological development thus go hand in hand. The importance of the interactions between technological development and organisational structure is to some extent reflected in Schumpeter's own work. In his *Theory of Economic Development* (1911) the focus of analysis and key actor driving forward technological progress was the entrepreneur. Later, in *Capitalism, Socialism and Democracy* (1942), Schumpeter examined the role of large firms and corporations with large R&D departments as the main contributors to technological development in capitalist economies. For Schumpeter, the organisational structure conducive to technological progress had thus evolved from the small scale entrepreneur to the large scale corporation. Similarly, Malerba and Orsenigo (1996) argue that at any given time, the existing technological environment will define the nature of the problems an organisation has to solve, the constraints and incentives facing an organisation in their operations and the dynamic mechanisms of the evolution of firms and industries. The features of the technological regime will therefore shape the specific patterns of innovative activities.

In addition, the organisational structure of a firm will be shaped by wider institutional features of society. Granovetter (1985) argues that common organisational features are partly due to their embeddedness in a common institutional context. The evolutionary economics literature thus argues that organisations operate within systems of innovation that are shaped by institutions and networks supporting or impeding technological change. For example, the actions of government and networks between government and firms are critical in determining the degree of innovative activity, while a number of public and private institutions, e.g. universities, can play a crucial part in the development and diffusion of new technologies. While it has been

argued that these systems are primarily national (Lundvall, 1988), it is interesting to note that very little is known about how national borders affect the flow of technological information and capabilities (Nelson, 1988). Finally, it should be noted that the systems of innovation are themselves adapting to technological developments. Accordingly, the institutional setting should by no means be seen as fixed, but rather as being in a continuous process of evolution.

In sum, the evolutionary economics literature highlights some serious limitations of the Neo-Schumpeterian Endogenous Growth literature. However, taken together, the two approaches allows for a thorough analysis of the processes of technological progress within capitalist economies at the level of the individual economic agent, the organisation, sector, market and wider national and international system of innovation. While the endogenous growth literature points to key areas in market structure and the activities of individual economic agents that promotes technological progress, the simplistic assumptions on which these findings are based represent weaknesses of the approach. The evolutionary economics literature attempts to unpick some of the assumptions on which endogenous growth theory is based, and illuminate black boxes that require further elaboration. In so doing, the literature points to a number of other issues that are central to our understanding of technological progress. In particular, the literature questions the simplistic view on organisations and their behaviour presented in the traditional economics literature.

Consequently, the evolutionary economics approach to economic analysis has a number of implications for how we understand the nature and role of human investment in modern economies. Notably, the transformation of organisations and complex processes of adaptation to new technologies apply as much to the provision of human investment as to the wider economy. Accordingly, an analysis of human investment must take account of how new technologies transform human investment provision itself, but also how such transformations are inextricably linked to the underpinning institutional framework and nature of the existing organisations. Moreover, the processes of technological development and economic growth, and the role of human investment in facilitating such processes, is not necessarily uniform across countries, but may take on different forms depending on existing institutional frameworks and organisational structures. Rather than viewing the role and processes

of human investment, as uniform across time and place, evolutionary economics alerts us to the diversity that any analysis of human investment must necessarily take account of. In other words, the analysis of human investment must be contextualised. These concerns have been echoed in the economic history literature and political economic analysis of human investment and its economic role. In the remainder of this chapter, the perspectives and lessons from these literatures will be reviewed.

2.2.6 Human investment, capital and growth – Perspectives from the economic history and political economy literatures

The relationship between economic growth and human capital formation has been further analysed in the economic history literature. In particular, it has been emphasised that an analysis of the role of human capital in the process of economic growth has to be contextualised to a given period so that it takes account of the unique features of the production processes that is specific to a given time. "By considering a longer time span and the interactions with cultural, institutional and technological development, one can better appreciate the complexities and issues of timing that may prove critical in the evolving nexus between human capital formation and economic growth" (David, 2001:79). Abramovitz and David (1999) find that the contribution of human capital to economic growth should be seen as particular to a historical era rather than an economic law that is universally valid. Based on quantitative estimates for the US from the 19th and 20th century they find great differences in the contribution of human capital to economic growth for different periods. More specifically, they argue that the growth in the 19th century was driven by tangible capital deepening with only a marginal contribution of total factor productivity. According to their analysis, the contribution of capital deepening during this period is closely related to the bias of the dominant technological development in favour of physical capital in effect replacing the requirement for skilled workers. In contrast, the 20th century, and in particular the latter decades of the century, saw a different technological development that was biased in favour of skills, and thus led to more investment in human capital which in turn contributed greatly to the economic growth of the period. Hence, as with the dynamic models of Acemoglu (1998, 2001), the relationship between technology and the role of human capital is being emphasised in

the study by Abramovitz and David (1999), although rather than framed in a model their work places the relationship in a wider historical context.
A different study by David and Wright (1999) suggests that the 20th century saw the emergence of a new 'techno-economic regime' which affects a multitude of industries and sectors. However, in order for the transition towards a new techno-economic regime to take place, a complementary organisational change of actors in the economy is required. It is in this context that human capital becomes of importance.

In sum, these studies have found "that the strong correlations between human capital and growth found by some modern cross-section and panel-data studies are a phenomenon particular to comparatively modern experience, not a regularity about the process of economic growth that can be expected to hold in any place and period" (David, 2001:11). Accordingly, any study of the relationship between human capital and economic growth must be placed in a historical context, and understand how the specifics of the particular period impinge on our understanding of what role human capital may play in the economy.

In fact, not only the role of human capital for growth, but also the processes of human investment are specific to a given period. Using formal education as a proxy of human investment is only useful for industrialised countries during the latter part of the twentieth century, because it is only for these particular countries and during this period that the predominant form of human investment has been provided through formalised institutions of education. Illich (1971) argues that during previous periods, and in other countries, the primary form of human investment may not be formalised, but take place at work or in the home. As an example it is worth noting Marx' resistance to a passage in the Gotha program that aimed to outlaw child labour, based on his assertion that the education of the young could only take place at work (Illich, 1971). Consequently, the conceptualisation and operationalisation of human investment must be periodically and geographically contextualised in order to provide valid indicators. For example, one of the weaknesses of some of the cross-country regression analysis has been the inclusion of both industrialised and developing countries in the same study, with formal education as the only proxy indicator for human capital.

Illich (1971) also places education and training within a wider political economic context. He argues that the formal institutionalised education system is a particular feature of modern societies that aim to keep individuals tied to an idea of progress through ever-increasing consumption and production and compares the role of the school to that previously held by the church.

> "The school system today performs the threefold function common to powerful churches throughout history. It is simultaneously the repository of society's myth, the institutionalization of that myth's contradictions, and the locus of the ritual which reproduces and veils the disparities between myth and reality. [...] No society has been able to survive without ritual or myth, but ours is the first which has needed such a dull, protracted, destructive, and expensive initiation into its myth. The contemporary world civilization is also the first one which has found it necessary to rationalize its fundamental initiation ritual in the name of education. We cannot begin a reform of education unless we first understand that neither individual learning nor social equality can be enhanced by ritual schooling. We cannot go beyond the consumer society unless we first understand that obligatory public schools inevitably reproduce such a society no matter what is taught in them."
>
> Illich (1971:37-38)

The argument that the processes of human investment need to be contextualised to the particular political-economic setting has been developed further in more recent literature. These efforts are based on a more heterogeneous understanding of capitalist societies. Accordingly, it is worth elaborating a bit on the theoretical foundations underpinning this analysis of the role and nature of human investment.

The varieties of capitalism approach developed by Hall and Soskice (2001) suggest that the modern capitalist societies in the developed world display substantial differences in their fundamental institutional frameworks. Such institutional differences give rise to different economic processes, and therefore play a critical part in determining a country's comparative advantage.

The cornerstone in the approach is the role of the firm and the inter- and intra-relationships that shape the activities of the firm. Accordingly, the institutional differences between countries are centred around five spheres "in which firms must develop relationships to resolve coordination problems central to their core competencies" (Hall and Soskice, 2001:7). These five spheres are as follows:

- Industrial relations; coordination of bargaining over wages and working conditions with the labour force.
- Vocational training and education; coordination of skill supply and demand.
- Corporate governance; coordination of supply and demand for finance for firms.
- Inter-firm relations; coordination of relationships with other enterprises, such as suppliers and clients.
- Employees; coordination of employees to ensure the requisite competencies and cooperation within the firm.

The dominant mechanism of coordination for each of these spheres is the key characteristic of the political economy. Hence, in liberal market economies, "firms coordinate their activities primarily via hierarchies and competitive market arrangements" (Hall and Soskice, 2001:8). In contrast, coordinated market economies are characterised by firms depending "more heavily on non-market relationships to coordinate their endeavours with other actors and to construct their core competencies" (Hall and Soskice, 2001:8). It is argued that the mechanisms in place create production regimes consisting of institutional complementarities. Accordingly, the means of coordination in the different spheres reinforce one another and shape particular ways of producing and competing internationally.

The implications of the varieties of capitalism approach for our understanding of the processes of human investment have been analysed by Estevez-Abe, Iversen and Soskice (2001). They cogently argue how the mechanisms of coordination in an economy shape incentives and opportunities for human investment. Central to their argument is that "different types of social protection are complementary to different skill equilibria" (Estevez-Abe et al, 2001:145). Hence, differences between countries

in the institutional complementarities constituting the welfare production regimes will create different patterns of human investment.

Their analysis is based on identifying three types of skills, general, industry-specific and firm-specific, and then outline how different welfare production regimes creates different incentives for investing in each of these types of skills. The different incentive structures in turn lead to different types of skills being prevalent within a given political economy. Notably, they draw links between the nature of employment and unemployment protection and skill formation. A political economy in which there is low employment protection and low unemployment protection will create an incentive to individuals to invest in general skills, since such skills are easily transferable and provides an alternative form of employment protection. Investing in skills which may be appropriate for a particular industry or firm makes the individual too inflexible for a system with little employment or unemployment protection. Moreover, there is little incentive for employers to invest in industry-specific skills, as employees can easily exploit their acquired skills for a higher wage at a competing firm. This is analogous to the argument in human capital theory discussed above, that employers are unlikely to invest in anything but very firm-specific skills. However, in the same way that employees have little job security with any given employer, so the employer has little guarantee of the employee staying with the firm, reducing the incentive for the employer to invest in firm-specific skills.

In contrast, a political economy in which both employment and unemployment protection is high, creates an incentive for current and future employees to invest in skills that improves their ability to execute a job in a particular industry and firm. This means investment in a mix of industry-specific and firm-specific skills. Moreover, Estevez-Abe et al (2001) argue that if wage settlements are agreed centrally by employer and employee representatives for the sector as a whole, and these settlements include obstacles to poaching of staff, it will be more difficult for workers to gain income by moving to a different employer. This is in effect a limitation of labour mobility which will increase the incentive for employers to invest in industry-specific skills. Hence, the guarantee of secure employment with the current firm can increase the incentive for both employees and employers to invest in firm-specific skills.

The other two alternative welfare production regimes are those with high unemployment protection but low employment protection, and high employment

protection and low unemployment protection. The former creates an incentive for employees to invest in industry-specific skills, because there is little assurance of staying with the same employer, but fewer problems attached to periods of unemployment. Accordingly, employees can afford to go unemployed for a period of time while they look for work within their particular industry. The latter welfare production regime creates an incentive for firm-specific skills, because employment with the current employer is reasonably secure. There is therefore only a need to invest in more general industry-specific skills in as so far as it contributes to performance within the current place of employment.

Hence, Estevez-Abe et al (2001) provide us with an analysis of human investment provision which suggests that different institutional framework and political economies will shape different forms of human investment provision. These varied types of skill production may in turn give rise to comparative advantages in different sectors. Consequently, it may be inappropriate to use overly simplified measurements of human investment and capital to capture what is in reality far more diverse phenomena.

All these issues must be taken into consideration when attempting to conceptualise and operationalise human investment in the era of the New Economy. It is with this in mind that the study in the following chapters will be conducted.

Chapter 3

Conceptualising Human Investment

A conceptualisation of human investment must start off with an acknowledgement of the relevance of the societal and historical context in which investment in human capital takes place. Rather than developing a universally applicable conceptualisation of human investment, the aim here is thus to contextualise human investment to the era of the New Economy. In order to do so, it is necessary first to briefly examine the relationship between education, society and the economy.

A historical perspective on education shows that the formal institutions of education that constitute the central part of human investment provision in European societies today, is a phenomenon that emerged during the late 19th and 20th century (Sanderson, 1983 and Illich, 1971). However, this is not to say that learning opportunities were not available before the late 19th century. Rather, processes of learning and education took a different form. Prior to the institutionalisation of universally available education, the majority of the population received their education from the church, family and their employers. Any specialist knowledge required for a job would be gained in an apprenticeship where the individual learned from the practitioner. The universally attended 'school' as we know it today is thus a fairly recent phenomenon emerging with the process of industrialisation and modernisation of society (Lawson and Silver, 1973).

With the emergence of industrial society, a range of new technologies allowed for a transformation of production processes with ensuing new roles and demand for labour. Landes (1970:41) summarises the technological developments that took place into three principles: "the substitution of machines – rapid, regular, precise, tireless – for human skill and effort; the substitution of inanimate for animate sources of power, in particular, the introduction of engines for converting heat into work, thereby opening to man a new and almost unlimited supply of energy; the use of new and far more abundant raw materials, in particular, the substitution of mineral for vegetable or animal substances". These three principles combined into a dramatic change of the European economies and societies during the 19th century. The average per capita

incomes experienced a sustained increase as the pace of technological and economic progress outpaced the population growth significantly. With the application of mechanisation to many sectors of the economy, productivity gains were realised at an unprecedented pace. It was now possible to produce large quantities of standardised products with machines taking the place of human and animal power in the production process. In particular, what set the technological progress of the industrial revolution apart from previous innovations was the cumulative and self-sustaining nature of the innovative activity and application of new technologies. Landes (1970) argues that two factors made this sustained wave of technological progress possible: "On the one hand, it required machines which not only replaced hand labour but compelled the concentration of production in factories – in other words, machines whose appetite for energy was too large for domestic sources of power and whose mechanical superiority was sufficient to break down the resistance of the older forms of hand production. On the other hand, it required a big industry producing a commodity of wide and elastic demand, such that (1) the mechanization of any one of its processes of manufacture would create serious strains in the others, and (2) the impact of improvements in this industry would be felt throughout the economy" (Landes, 1970:81). Hence, the technological breakthroughs that initiated the industrial revolution had significant ramifications for the entire economy, setting in motion a sustained period of rapid technological innovation and application.

However, the technological progress of the industrial revolution should not be regarded as an automatic process. Rather, such progress is dependent upon and shaped by the ability of individuals and societies to adapt to the new technologies and the changes they bring about. In particular, the technological progress ushered in by the industrial revolution inevitably initiated changes in society posing a number of new challenges for people's lives and livelihoods. The ability and willingness of people to accept these changes and adapt their life and work to incorporate the new products and processes was thus essential for the emergence of industrial society (Landes, 1970).

More specifically, industrialisation meant the displacement of production and work, putting pressure on labourers to adapt to the new production processes. The rise of industrial mass production transferred work from small-scale businesses to the assembly lines in large factories. Consequently, the role of the worker became one of

operating machines in factories producing large quantities of standardised goods rather than the performance of skilled craftmanship or work in the field.
The changes to the role of labour meant that new skills and abilities were required. Instead of the specific skills for craftmanship or fieldwork, the worker now needed basic skills to operate machinery and understand instructions. The ability to receive and understand written and numerical instruction became of increasing importance. Education was seen as having a central role in ensuring the provision of a labour force with these required skills. With the rise of industrial society thus also came calls for the education of the labour force. In Britain, the message was made clear by the Schools Inquiry Commission in 1868 as it reported the following passage:

> "our industrial classes have not even that basis of sound general education on which alone technical instruction can rest. It would not be difficult, if our artizans were otherwise well educated, to establish schools for technical instruction of whatever kind might be needed. But even if such schools were generally established among us, there is reason to fear that they would fail to produce any valuable results for want of the essential material, namely, disciplined faculties and sound elementary knowledge in the learners. In fact, our deficiency is not merely a deficiency in technical instruction, but [...] in general intelligence, and unless we remedy this want we shall gradually but surely find that our undeniable superiority in wealth and perhaps in energy will not save us from decline"
>
> (Taunton Report, 1868:79-80).

Hence, industrialisation made the provision of education a highly prioritised objective for policymakers, with the state being seen as having an important role to play in ensuring the access to education for all. In Britain, the pioneering country of the industrial revolution, the result was the Elementary Education Act of 1870, which gave the state an unprecedented role in education (Lawson and Silver, 1973). The aim of the new Act was to ensure the provision of school education "for all the children resident in such district for whose elementary education efficient and suitable provision is not otherwise made." If the existing provision is inadequte "a school board shall be formed for such district and shall supply such deficiency" (Elementary Education Act of 1870 quoted from Lawson and Silver, 1973:316). The Education

Act of 1870 was a pivotal moment in the development of the modern educational system in Britain. As the British industrial society became ever more sophisticated, and the technologies more complex, so the system of education had to develop as well. As the production processes called for more specialised and skilled labour, so the formal education system expanded the provision of education from basic elementary schooling to the current system of primary, secondary and tertiary education.

However, the provision of work-related skills to the labour force was not the only role of the newly created formal education system. Perhaps more importantly, the new education system gave people the skills and abilities to operate within and partake in industrial society at large and generated an acceptance of the wider changes that the technological progress inevitably brought about. Hence, education "had important wider bearings on the creation of industrial society. Education effected psychological changes and helped to break down the isolation of rural communities with their limited horizons. By making it possible for people to be in touch with 'a basic network for information dispersal' (by reading notices at least), it could make them aware of possibilities open to them, of jobs for labourers or products for consumers. Notice reading would also alleviate the problem of safety in dangerous mines and factories. It enabled the efficient functioning of an urban industrial society laced with letter writing, drawing up wills, apprenticeship indentures, passing bills of exchange, and notice and advertisement reading. For such reasons a positive belief in the value of education on the part of the authorities replaced earlier assumptions that teaching the poor to read would merely lead to the diffusion of subversive literature and a wholesale flight by the newly educated from menial tasks" (Sanderson, 1983:18).

It is evident from the above, that the formal education system as we know it today has grown out of and played a significant role in shaping the modern industrial society. In light of this, a conceptualisation of human capital investment in the era of the New Economy requires an examination of how the provision of education is affected by the emergence of a knowledge-based information economy and society. In order to do so, it is necessary first, briefly, to establish what constitutes the New Economy, which will be attempted in the following section.

3.1 The New Economy

The New Economy paradigm has emerged as an attempt to understand the changes to modern economies caused by the introduction and widespread diffusion of information and communication technologies. Crucial to the New Economy paradigm is an understanding of information and communication technologies as not only new products, but also as acting as catalysts for a transformation of fundamental economic and social processes and activities. Rather than merely being a new additional product to businesses and households, the utilisation of information and communication technology constitutes a change in the way producers and consumers conduct their business. It is thus argued that these new technological developments are of a significantly different nature than other improvements in products and processes that industrialised economies have experienced since the end of World War II. In order to understand the reasoning behind this argument, it is necessary to explore in greater detail what information and communication technologies do.

Firstly, information and communication technologies (ICT) increase the speed and number of ways in which electronic information can be transferred from one person or machine to another. This increased speed at which electronic information can be created, sent and processed is partly achieved by an increase in processing power of information and communication tools. For example, from the fourth quarter of 1993 to the fourth quarter of 1999, the performance-price ratio of computer processors improved by a factor of 16.2, while the performance-price ratio for hard disk capacity improved over the same period by a factor of 176 (Gordon, 2000). Furthermore, the increased speed in communicating and processing information was made possible with tools available in numerous new localities such as the home, the office, or even while on the road. While the tools required for processing electronic information were previously covering entire rooms from wall to wall, great computer power can now be used in machines the size of a human hand. This has allowed people to access large amounts of electronic information while sitting in their living rooms in front of a personal computer, or while on the road through laptops and mobile phones.

Secondly, developments in information and communication technologies, have made it possible to store and transfer many different types of information electronically that previously took a non-electronic form. It has thus been argued that the developments within ICT have allowed for the electronification of vast amounts of information that

is crucial for the efficient operation of production and consumption processes. This has led some observers to regard information and communication technology as a 'general purpose technology' – "one useful not just for one narrow class but for an extremely wide variety of production processes, one for which each decline in price appears to bring forth new uses, one that can spark off a long-lasting major economic transformation. Such general purpose technologies are, as Bresnahan and Trajtenberg [1995] say, 'engines of growth': precisely because they have a wide range of potential uses, and are complementary to a large proportion of other inputs, their price elasticity of demand is likely to be high" (DeLong and Summers, 2001)

These two aspects of ICT combine into a forceful alteration of the ways in which information can be used in production and consumption processes. By increasing the speed at which electronic information can be transferred and processed, and giving a number of different types of information and knowledge an electronic form, ICT enhances the role of electronic information in economic processes. Indeed, some economists have suggested that the introduction and diffusion of ICT represent a fundamental challenge to our understanding of economic phenomena. It has thus been argued that the ability to transform information into an electronic form and communicate this information in virtually no time, "drive[s] the lags and latencies out of the economy and make it much more efficient" (Siegele, 2002:4).

Accordingly, the New Economy paradigm asserts that the developments within ICT represent a significant transformation in the way economies operate.

Furthermore, the role of communicating information and knowledge in the process of developing new knowledge and information is important. Also here, the new technological developments will have a significant impact. As Castells (1996, p.32) argues, "What characterises the current technological revolution is not the centrality of knowledge and information, but the application of such knowledge and information to knowledge generation and information processing/communication devices, in a cumulative feedback loop between innovation and the uses of innovation". Consequently, the new developments in ICT will accelerate the process of technological innovation, and the diffusion and utilisation of these technological innovations. ICT thus represents a technological innovation that improves the process of technological innovation itself.

Given the role of technology in generating more efficient production processes and improved products, economists have argued that the above mentioned features of ICT give rise to a higher rate of productivity growth. The potential of an accelerated rate of productivity growth represents one of the most interesting and contested aspects of the New Economy.

3.1.1 New Economy and productivity growth

Despite already having the world's highest level of GDP per capita in 1990, the trend growth accelerated in the United states over the 1990s, while the trend growth for many other less well off industrialised countries stagnated during the same period (OECD, 2001). In particular, the latter half of the decade saw a marked acceleration in US economic growth. The rate of growth of US GDP thus increased from an average of 2.86% per year during the period 1973-1990 and an annual 2.36% in the first half of the 1990s, to an average of 4.08% during 1995-1999 (Jorgenson, 2001). This economic progress in the US was not only a source of envy for all other countries in the world, but also constituted a challenge for economists to explain (Gordon, 1998). So many features of the economic boom seemed to contradict existing explanations of growth and cycles. As Temple (2002:241) sums up: "The US expansion which came to an end in 2001 had lasted exactly 10 years, one of the longest unbroken expansions ever recorded by an industrial country. The rate of inflation stayed low throughout, even though the unemployment rate fell to a 30-year low. Faster productivity growth ultimately translated into faster growth in real wages. The incidence of poverty fell, and wage inequality finally stabilized". While these developments were not unique to the US, they were much more pronounced in the American economy, and constituted more of an economic conundrum given the role of the United States as leading industrialised economy.

The sustained economic expansion during the 1990s was explained by an underpinning acceleration in productivity growth, with the annual labour productivity growth in the US moving from an average of 1.26% in 1973-1990 to 1.19% in 1990-1995 and 2.11% during the period 1995-1999 (Jorgenson, 2001). Explanations for this rise in productivity growth were in turn sought by looking at the increasing role of ICT in the US economy. More specifically, economists turned their attention to the

huge productivity gains in the production of semiconductors, and the effects of these developments on the production of information and communication products.

The technological advances in the semiconductor industry was described in an observation by Gordon E. Moore back in 1965, which has later come to be known as Moore's Law: Based on data on memory chips, Moore saw that a new version of chips was developed within 18-24 months of its predecessor, and that each new version of chips contained approximately twice as many transistors as the previous version. By implication, this would mean exponential growth of chip capacity at 35-45% per year. Similar developments were later to take place for logic chips, with programmable functions allowing for processing of information. The first logic chip developed in 1971 had 2,300 transistors, while the Pentium 4 chip released by Intel in 2000 had 42 million transistors (Jorgenson, 2001). As a result of this dramatic rate of improvement of semiconductors, the price for semiconductors has fallen at an equally impressive rate. As Jorgenson (2001:3) states:

"Between 1974 and 1996 prices of memory chips *decreased* by a factor of 27,270 times or at 40.9 percent per year, while the implicit deflator for the gross domestic product (GDP) *increased* by almost 2.7 times or 4.6 percent per year! Prices of logic chips, available for the shorter period 1985 to 1996, *decreased* by a factor of 1,938 or 54.1 percent per year, while the GDP deflator *increased* by 1.3 times or 2.6 percent per year!"[1]

The rate of improvements in the semiconductor industry was further accelerated in the mid-1990s, when it shifted from a three-year product cycle to a two-year cycle. This resulted in the microprocessor price decline reaching 90 percent per year in 1994 and 1995 (Jorgenson, 2001).

The rapid improvement in the price and capacity of semiconductors found its most potent application in the computer industry. Having purchased Intel's 8086-8088 microprocessor in 1978, IBM launched the first Personal Computer in 1981. In that same year IBM licensed the MS-DOS operating system from the Microsoft

[1] It should be noted that these price declines are for chips with constant quality.

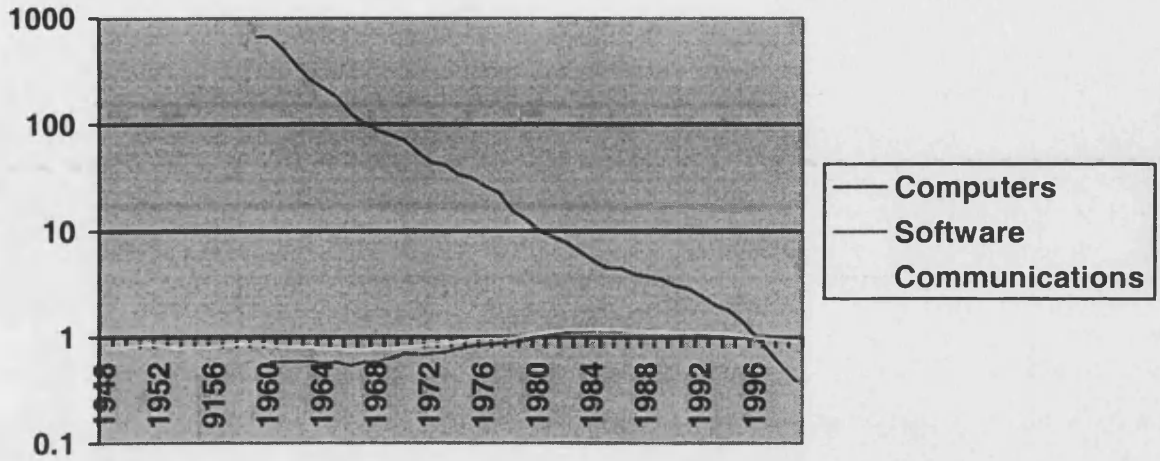
Corporation, and set the wheels in motion for what would be a revolution in the way people use, communicate and process information. The technological innovation in the computer industry, for both mainframe and personal computers, coupled with the continued improvement in semiconductors led to a sharp decline in the price of computers.

The continued improvements in the quality, and reduction in price, of semiconductors and computers, led to an expansion in the production of tools and applications to be used with computers, in particular software and communications equipment. The advancement of these products expanded the ways in which semiconductors and computers could be put to use and created the foundation for the development and diffusion of information and communications technology. In addition, the technological development in the communication equipment sector has been as rapid as that for semiconductors. For example, the development and installation of dense wavelength division multiplexing that sends multiple signals over an optical fiber simultaneously, has doubled the transmission capacity of fiber-optic cables every 6-12 months since 1997 (Rashad, 2000). Similarly, the software industry experienced technological improvements since the mid-1980s (Jorgenson, 2001).

These technological breakthroughs were reflected in lower prices for both communication equipment and software, albeit a less dramatic decline in price than that seen for the price of computers (see Graph 1).

Graph 1

Price indices for Computers, Software and Communication equipment 1948-1999 (1996=1)



It should be noted that the prices for computers are quality adjusted, while those of software and communications are not.

Taken together, the technological developments outlined above made the use, processing and communication of information 'better, faster and cheaper'.

The application and utilisation of ICT

As a result of the technological breakthroughs in information and communication technology, and the ensuing price decline for ICT products, information became an attractive factor of production. This instigated the second stage of the process towards the New Economy, which was the application of the new technologies to production processes in other sectors of the economy. While the massive productivity gains within the ICT sector itself remain undisputed, the significance of these developments for the economy as a whole, and the extent to which one can talk of a New Economy, is very much dependent on the degree to which these new technologies can transform and improve production and consumption processes in other sectors of the economy. The most crucial aspect of the New Economy paradigm is therefore the significance of ICT for the economy as a whole.

The initial data on the application of ICT in the US economy shows a rapid increase in ICT investment during the 1990s. Throughout the decade, US firms invested more than $2.4 trillion in ICT assets (Stiroh, 2002). Much of the increased investment in ICT substituted for other kinds of physical investment, which is reflected in the shift in composition of fixed investment from buildings towards equipment. Equipment investment thus rose as share of GDP from 7.5% to approximately 10%, while the proportion of GDP going to fixed investment as a whole rose only moderately (Temple, 2002). Given the massive increase in quality of ICT products and services throughout this period, the actual quality adjusted increase in ICT investment was immense. For the economy as a whole, the effect of this increased ICT investment was an accelerated productivity growth. Jorgenson (2001) estimates that ICT's contribution to labour productivity growth increased significantly during the period 1973 to 1999 (see table 1).

Source of US average labour productivity growth in %-point of average labour productivity growth

	1948 - 1973	1973 - 1990	1990 - 1995	1995 – 1999
Average labour productivity growth	**2.82**	**1.26**	**1.19**	**2.11**
Contribution of capital deepening	**1.45**	**0.79**	**0.64**	**1.24**
Information Technology	*0.15*	*0.35*	*0.43*	*0.89*
Noninformation Technology	*1.30*	*0.44*	*0.21*	*0.35*
Contribution of labour quality	**0.46**	**0.22**	**0.32**	**0.12**
Total factor productivity	**0.92**	**0.25**	**0.24**	**0.75**
Information Technology	*0.06*	*0.19*	*0.25*	*0.50*
Noninformation Technology	*0.86*	*0.06*	*-0.01*	*0.25*

Source: Jorgenson 2001
Table 1

It is evident from the table above that a large proportion of the increase in labour productivity growth that occurred during the latter half of the 1990s can be attributed

to the emergence of information technology. Overall, the average increase in the labour productivity growth rate from the first to the second half of the 1990s was 0.92%. Half of this increase can be attributed to capital deepening in the form of information technology, and a further 0.25% was due to increases in total factor productivity resulting from the introduction and diffusion of information technology. More than three-quarters of the increase in the labour productivity growth rate between the two periods was thus due to information technology.

Similar developments took place to different extents across Europe. During the latter half of the 1990s, investment in ICT grew at a similar rate in the European Union as in the US. Over the period between 1995 and 2000, the average annual growth rate of ICT investment was 18.5% in the European Union compared to 19.3% in the US (van Ark et al, 2003). However, the starting points for the two economic areas were very different, with ICT investment levels as a percentage of GDP differing significantly (Table 2).

Total ICT investment as % of GDP, excluding rents

	1980	1985	1990	1995	2000
European Union	1.3	1.9	2.3	2.2	2.9
United States	2.8	3.8	3.7	4.1	5.3

Table 2 Source: van Ark et al, 2003

Hence, while there has been a significant contribution by ICT to productivity growth during the 1990s in the European Union, it has been much less pronounced than in the US. Furthermore, there has not been an accelerated productivity growth in the European Union as a whole, like the US economy experienced during the latter half of the 1990s (Table 3).

Contribution of ICT Capital, Non-ICT Capital and TFP to Annual Average Labour Productivity Growth in the European Union, 1980-2000, as %-point contribution

	1980-1985	1985-1990	1990-1995	1995-2000
ICT Capital Deepening	0.3	0.33	0.28	0.40
Non-ICT Capital Deepening	0.97	0.64	1.05	0.40
TFP Growth	1.26	1.02	1.12	0.62
Labour Productivity Growth	2.53	2.00	2.45	1.43

Table 3 Source: van Ark et al, 2003

Further evidence of the contribution of ICT to the accelerated productivity growth in the US is found when the productivity and investment data is broken down by sector. The US investment boom in ICT equipment and concomitant productivity growth, was thus not evenly distributed across all sectors of the economy. Some sectors were far quicker at making use of the new technologies, and applications specific for these industries were developed much faster. Data suggests that the biggest increases in the rate of productivity growth took place in some of the large service industries such as wholesale and retail trade and finance, coupled with durable manufacturing. These were also the most IT intensive industries as measured by their IT spending relative to value added. "The intense-IT-using industries showed much faster labor productivity growth over the entire period 1989-1999 and showed about a 50-percent larger acceleration after 1995" (Baily and Lawrence, 2001:309).

US labour productivity growth by industry

Industry	1980 –1995	1995 - 1999	Difference
Private Industries	**0.88**	**2.31**	**1.43**
Agriculture	0.34	1.18	0.84
Mining	4.56	4.06	-0.50
Construction	-0.10	-0.89	-0.79
Manufacturing	3.18	4.34	1.16
Durables	*4.34*	*6.84*	*2.51*
Non-durables	*1.65*	*1.07*	*-0.59*
Transportation	2.48	1.72	-0.76
Trucking & warehouse	*2.09*	*-0.73*	*-2.82*
Transportation by air	*4.52*	*4.52*	*0.00*
Other transportation	*1.51*	*2.14*	*0.63*
Communication	5.07	2.66	-2.41
Electric/gas/sanitary	2.51	2.42	-0.09
Wholesale trade	2.84	7.84	4.99
Retail trade	0.68	4.93	4.25
F.I.R.E.	1.70	2.67	0.97
Finance	*3.18*	*6.76*	*3.58*
Insurance	*-0.28*	*0.44*	*0.72*
Real Estate	*1.38*	*2.87*	*1.49*
Services	-1.12	-0.19	0.93
Personal services	*-1.47*	*1.09*	*2.55*
Business services	*-0.16*	*1.69*	*1.85*
Health services	*-2.31*	*-1.06*	*1.26*
Other services	*-0.72*	*-0.71*	*0.01*
Intense IT users	**2.43**	**4.18**	**1.75**
Less-intense IT users	**-0.10**	**1.05**	**1.15**

Source: Council of Economic Advisers 2001
Table 4

However, to what extent can ICT be applied to the sectors of the economy that have so far failed to experience an acceleration in productivity growth, and what are the limits to the future contribution of ICT to sectors that have already seen a rapid rise in their productivity growth? In other words, can this level of investment and productivity growth in the economy continue? Are the productivity gains experienced during the latter half of the 1990s a one-off, or do they represent the beginnings of a new economic era with continued high rates of productivity growth?

The answer to this question depends on whether and to what extent ICT can be applied to production processes in other sectors of the economy, and the degree to which the application and utilisation of ICT contributes to productivity growth?
This remains probably the most debated issue in the literature on the New Economy. As one of the leading critics of the idea that ICT represents a new technological era in line with the industrial revolutions of the past, Gordon (2000:72) argues that "The fundamental limitation on the contribution to productivity of computers in general and the Internet in particular occurs because of the tension between rapid exponential growth in computer speed and memory on the one hand and the fixed endowment of human time. Most of the initial applications of mainframe and personal computers have encountered the rapid onset of diminishing returns. Much of the use of the Internet represents a substitution from one type of entertainment or information-gathering for another".

In contrast, others have argued that ICT represents a General Purpose Technology, i.e. a technological development with a wide range of applications, which represents a significant contribution to the production process in many of the various sectors that it can be applied to. The emergence of a General Purpose Technology will therefore set in motion a sustained period of frenzied innovative activity, as many sectors of the economy attempts to develop new applications to their production processes. Consequently, such a technological innovation will have significant economic implications for all sectors of the economy, resulting in sustained increases in productivity for the economy as a whole.
Delong and Summers (2001) argue that a key determinant of the extent to which a new technology can be classified as a General Purpose Technology is the price and income elasticities of demand of the new technology products. "The more are high-tech products seen as 'luxury' goods, and the greater is the number of different uses found for high-tech products as their prices decline, the larger will be the income and price elasticities of demand—and thus the stronger will be the forces pushing the expenditure share up, not down, as technological advance continues" (Delong and Summers, 2001:8).
They go on to argue that the developments within ICT may well fall into such a category. In particular, the potential demand-side externalities also known as 'network

effects' (Metcalfe's law) are likely to contribute to a higher elasticity of demand[2]. Delong and Summers sums these aspects of ICT into an optimistic note on the future of ICT and its applications:

> "In the most recent years the evolution of the computer and its uses has continued. It has branched along two quite different paths. First, computers have burrowed inside conventional products as they have become embedded systems. Second, computers have connected outside to create what we call the world wide web: a distributed global database of information all accessible through the single global network. Paralleling the revolution in data processing capacity has been a similar revolution in data communications capacity. There is no sign that the domain of potential uses has been exhausted. So far there are no good reasons to believe that the economic salience of high-tech industries are about to decline, or that the pace at which innovation continues is about to flag."
>
> Delong and Summers (2001:12)

In addition, it has been argued that the wider availability of information as a result of ICT, adds to the competitive pressure on companies. The added competition will in turn force companies to develop applications of new technologies at a more rapid pace, in order to gain an advantage in the market (Reich, 2001).

However, this may well be too simplistic an analysis of the potential economic benefits of ICT. In order to ascertain whether the elasticity of demand for ICT products is likely to be high or low, we need to assess the determinants of the relevant elasticity. Here we need to understand the nature of ICT and the role it plays in contributing to productivity growth. This in turn depends on the role of information in the production process, which is a particularly contentious issue. Information in itself may play a very minor role in the economy if our abilities as individuals to process and work with information remain static. As Zvi Griliches once wrote, "The cost of computing has dropped exponentially, but the cost of thinking is what it always was"

[2] However, as Krugman (2000) makes clear, offsetting Metcalfe's law is the point that it is the most

(Gordon, 2000). Consequently, economists taking a more sceptical view of the notion of a New Economy, have suggested that the impact of information technology on long-term productivity growth will be rather limited. Gordon (2000) estimates the price elasticity of demand for computers as having declined from –2.03 in the period 1960-72 to –1.97 during 1972-87, -1.64 in 1987-1995 and finally to -1.36 for the period 1995-1999. Such declines in price elasticity have been coupled with an apparent rapid slide down the demand curve for computers to lower marginal utility levels, reflecting quickly diminishing returns to computers. This is in turn explained by the limited contribution of computers to our productivity. "Computers are a relatively large share of capital in business, health, legal, and educational services, but in each of these the contribution of capital to productivity growth is relatively small. No matter how powerful the computer hardware and how user-friendly the software, most functions provided by personal computers, including word processing, spreadsheets, and database management, still require hands-on human contact to be productive, and that need for human contact creates diminishing returns for the productivity impact of the computer" (Gordon, 2000:66). In other words, while ICT investment has increased rapidly, our need to contribute a vast amount of labour time to all the processes to which ICT can be applied, combined with the fact that we have a fixed amount of time as workers, yields a fairly low overall productivity gain as a result of utilising ICT in production processes. This would suggest the inappropriateness of the assertion that ICT is a General Purpose Technology.

However, is it right to assert that the cost of thinking has remained the same as it always was? Is there anyway in which ICT could be made more applicable to different sectors in the economy? Here I shall argue that this will depend on the skills and abilities of workers to work and process information, which in turn is determined by the available human capital in the economy.

3.2 Human capital investment and the New Economy

Skill-biased technological change

Increasing evidence seems to suggest that a key characteristic of the recent technological developments in ICT is its skill-bias. Preliminary evidence to support

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valuable nodes that are connected to the network first (also known as 'Delong's law').

the view that the introduction and diffusion of ICT represents a skill-biased technological development can be found from the labour markets across the OECD countries. The last two to three decades have seen a considerable increase in the number of skilled workers employed in the OECD labour markets both in absolute numbers and relative to the employment levels of unskilled workers (table 1 and 2).

Aggregate Trends in Graduate/Non-graduate Employment, Hours and Relative Wages, UK 1980-2000

	% Graduate Share of Employment	% Graduate Share of Hours	Relative Weekly Wage (Full-timers)
1980	5.0	5.1	1.48
1985	9.8	10.5	1.50
1990	10.2	11.0	1.60
1995	14.0	15.4	1.60
2000	17.2	18.8	1.64
1980 – 2000	12.2	13.7	0.12
1980 – 1990	5.2	5.9	0.08
1990 – 2000	7.0	7.8	0.04

Table 5 Source: UK Labour Force Survey/General Household Survey in Machin (2001)

Aggregate Trends in Graduate/Non-Graduate Employment, Hours and Relative Wages, US 1980-2000

	% Graduate Share of Employment	% Graduate Share of Hours	Relative Hourly Wage (Full-Timers)
1980	19.3	20.4	1.36
1985	22.0	23.6	1.47
1990	23.8	25.6	1.55
1995	25.5	28.1	1.61
2000	27.5	29.5	1.66
1980 – 2000	8.2	9.1	0.30
1980 – 1990	4.5	5.2	0.19
1990 – 2000	3.7	3.9	0.11

Table 6 Source: US Current Population Survey in Machin (2001)

It is evident from the tables above that there has been a marked increase in the relative numbers of skilled workers in the UK and US labour markets. However, what is perhaps of more interest is the fact that the increased relative supply of skilled workers has been coupled with an increase in the relative wage of skilled workers (graduates) compared to their less skilled counterparts (non-graduates).

This phenomenon has represented a major conundrum to labour economists in recent times. If the relative supply of skilled workers increased one would expect an ensuing decline in the relative wage of skilled workers. The fact that the opposite has occurred must therefore be explained by a relative increase in the demand for skilled workers, which is greater than the relative increase in supply. However, how can this increase in relative demand for skilled workers be explained?

Attention turned to the role of ICT and its skill-biased nature. Contrary to much of the economic theory that deals with technological development, the effectiveness with which workers can make use of new technological applications or processes is not equal. Rather, some technologies serve the purpose of replacing the need for skills, while others will complement or even require highly skilled labour. Consequently, technological developments will increase the productivity of differently skilled workers to different degrees. Un-skilled-biased technology, developed during the 19th and early 20th century, allowed for the introduction of Fordist assembly line production, and increased the productivity of unskilled workers. By reducing the skill requirement to produce a range of goods, which were previously produced by skilled craftsmen, the relative demand for and hence the relative wages of unskilled workers increased.

With ICT, the new technological developments have allowed for a better, faster and cheaper processing and communication of information. However, as the quote by Griliches makes clear, in order to make use of this new technology, we as human beings must be able to work with information and the new technologies in an efficient way. The speed and quality with which we can work with information is in turn dependent upon our skill levels. Hence, it has been argued that ICT requires a certain amount of skills in order to be used efficiently. The ensuing productivity gains resulting from the utilisation of ICT are thus greater for skilled workers relative to less skilled workers, which, ceteris paribus and assuming perfectly competitive markets for factors of production, leads to a widening wage gap between the two types of workers.

The skill-biased nature of ICT is further highlighted when examining the nature of the innovations and their possible applications. Autor, Levy and Murnane (2002:1) argue that computers can be used for "the execution of procedural or rules-based logic", and

this has significant implications for what kind of skills are required for the application and utilisation of such technology. For example, "Many repetitive manual tasks that workers perform or used to perform at their jobs, such as monitoring the temperature of a steel finishing line or moving a windshield into place on an assembly line, can now be specified with straightforward computer code and accomplished by machines. A problem that arises with many other tasks, however, is that, as Michael Polanyi (1966) observed, 'we do not know how to do many of the things we do'" (Autor, Levy & Murnane, 2002:4). A distinction can thus be made between routine tasks, which can be accomplished by following a set of explicit rules, and non-routine tasks which require adaptive processing capacities that cannot currently be described in terms of a set of programmable rules.

People with a comparative advantage in performing non-routine relative to routine tasks will use ICT as a complementing factor of production, while for people possessing a comparative advantage in routine tasks ICT represents a substituting factor of production.

Assuming that the skill-level is a key factor determining a workers comparative advantage in routine versus non-routine tasks, the relationship between ICT and the wage-gap between skilled and unskilled workers can be explained. Human capital can thus be conceptualised as the variable that determines a person's comparative advantage in performing non-routine tasks. By implication, a country with high levels of human capital would have a comparative advantage in the areas of production requiring the execution of non-routine tasks. The ability to appropriate the benefits of ICT are thus dependent upon the available human capital and continued investment in human capital, in the same way that physical capital and investment in physical capital was a condition for the productivity gains achieved with the emergence of industrial production during the 19th and 20th century.

A different way of looking at this is to suggest that human capital is what turns information into productive knowledge and technological development. In order to benefit from the cheap and easily accessible information that is available as a result of the application of ICT, an economic agent requires the complementing human capital. While investment in ICT is of course a necessity for the emergence of the New Economy, a supplementary requirement is thus the sustained investment in human capital, or at least ensuring that a certain stock of human capital is available.

The investment in human capital and technological progress of ICT thus go hand in hand, and a significant characteristic of the New Economy is the role of human capital as a dominant factor of production. In accordance with the analysis by Acemoglu (1998) reviewed in chapter 2, the dynamic relationship between technological development and factors of production means that the increase in human capital will further the development of ICT and the New Economy. In contrast, if workers expectations about future returns are such that they decline to invest further in human capital, or if they are otherwise constrained in their opportunities to undertake human investment, the result may also be a stagnated technological progress, or a different trajectory of technological development that is less biased towards human capital. The result is likely to be that the full productive potential of ICT is left unexploited.
Moreover, the sustained and more rapid rate of technological progress characterising the New Economy, requires people to undertake human investment throughout their working lives. Consequently, a conceptualisation of human investment cannot be limited to the education received prior to entering the labour market, but must encompass all the education, training and learning that is taking place for individuals throughout their lives. Indeed, it has been highlighted that ICT can play an important role in facilitating human investment provision in a number of new ways within and outside of the formal education system (Samuels, 2001; Harrison, Comber, Fisher et al, 2002; Gorard, 2003; and Gorard, Selwyn and Madden 2003).

In the New Economy there is thus a new dynamic relationship between human capital investment and technological progress that requires us to rethink the nature of human investment. The initial steps that have been taken at the policy level are to introduce the concept lifelong learning. The dimensions to this concept are far more wide reaching than merely the issue of when during a persons life education and training is received. Lifelong learning involves a re-conceptualisation of when, where and how human investment is provided.

3.3 Lifelong learning

The notion of lifelong learning represents a paradigm shift in our understanding of human investment. "Lifelong learning is no longer just one aspect of education and training; it must become the guiding principle for provision and participation across

the full continuum of learning contexts" (Commission of the European Communities, 2000:3). Its central feature is a move from an institutionally based understanding of education towards one based on the needs and requirements of the individual. Consequently, one of the key adaptations brought about by lifelong learning is that education and training no longer has to take place within an educational institution or organisation. Rather, new ways of learning have been highlighted with the introduction of 'informal' and 'non-formal' learning. Lifelong learning thus expands our understanding of education from a single-dimensional institutionalised provision to a multi-dimensional individualised provision. As Tuijnman (2002) notes, "the emphasis on learning rather than education is highly significant because it reduces the preoccupation with social structures and instead focuses on individual demand" (Tuijnman, 2002:5). The emergence of multiple dimensions of education and training can be captured in a framework of lifelong learning build around three main education environments:

- formal education environment, which is the formalised institution based education
- non-formal education environment, which encompasses the learning taking place in or associated with the workplace, such as on-the-job learning and training provided by employers
- informal education environment, which is shaped by the household and may facilitate learning during activities which are not traditionally considered part of an education process, such as learning by doing and learning by using ICT at home

Formal institution based education

Formal education includes all the formal institutions and organisations of education that teach students mainly prior to them entering the labour market. This includes primary, secondary and tertiary education. The boundaries of formal education are set at the direct participation in the institutions of education. Consequently, the formal education is an element of human investment that people receive in institutions dedicated to educating the participants, predominantly prior to entering the labour market.

The impact of the new economy on traditional institutions of education has already been immense. Not only have institutions of education seen an increasing demand for their services, but also experienced great pressure to change existing methods of education to the new technological developments and ensuing transformation of economic and social affairs. These changes are exemplified by the European wide political objectives of increasing the number of students who receive tertiary education and introducing information and communication technologies in the classrooms as educational tools.

The pursuit of both of these objectives has implications for our understanding of the provision of education. For example, what are the qualitative changes required for the successful application and utilisation of ICT for human investment purposes in the formal education environment?

Non-formal education environment

The non-formal education environment has always been a key element of human investment, but has often been neglected in the conceptual and empirical work in the economics literature. The non-formal element of human investment constitutes the learning, education and training activities that take place in the workplace or is provided to people as part of their employment. The opportunities for creating this category of educational environment has been greatly enhanced as a result of the introduction of ICT as a learning tool in human investment provision. The introduction of ICT in the workplace has allowed for learning to take place while people are working, and give access to a wide range of information and knowledge stocks at the desks where people work. In addition, it has created the opportunity for training and learning provision to take place electronically and at a distance from the creator and provider of the human investment service.

However, more fundamental changes to non-formal education are taking place, and have to be understood in relation to the more fundamental changes to production and economic activities discussed in the sections above. Given the transformation in production processes that occurs as a result of the skill-biased technological changes of the New Economy, the activities of labour are changing. From an emphasis on routine tasks, the role of employees is moving towards non-routine tasks. Learning these new tasks can now more easily be done as a result of the introduction of ICT.

In particular, in as so far as a defining aspect of the New Economy is the intensified pace of creative destruction, there is increased pressure on workers to update their skills and familiarise themselves with new technologies and processes of production. If this can be done more efficiently and at a lower opportunity cost at the workplace, as a result of the utilisation of ICT, the non-formal education environment may play an increasingly important role in a country's human investment strategy.

It is important to emphasise, however, that the changes to the non-formal education environment is not limited to the activities of the individual employee. Rather, fundamental changes are taking place at the level of the organisation. These transformations have been captured in the notion of the learning organisation (Senge, 1990), referring to an organisation that is capable of adapting to a continually changing environment through processes of learning. This involves structural change but also, and perhaps more importantly, a cultural change to the organisation. Again, the role of ICT in facilitating the creation of learning organisations may become increasingly important, as the new technologies allow access to and storage of information and knowledge and increasing access to networks, which in turn facilitate new means of communication and management within the organisation.

The non-formal education environment thus highlights that human investment can be achieved, not only by bringing people into formal education institutions, but also by reshaping other areas of people's life, in this case the workplace, into educational environments. ICT can play a critical role in this respect.

Informal education environment

The idea that other areas of an individual's life can be transformed into educational environments is further highlighted when applied to the household. Education and training therefore not only takes place in formal educational institutions and non-formally in the workplace, but is also achieved domestically in peoples' homes. However, such learning activity requires the necessary educational qualitative features to be present in the home. The opportunities for these qualitative features to be in the home have potentially been greatly enhanced by the emergence of ICT.

In addition, it is important to emphasise that the three categories of education do not take place in isolation from each other. Indeed, it could be argued that a significant change of our understanding of human investment that has come about as a result of

ICT is the intensification of the interaction between the various educational environments. Not only do we now have different educational environments; the borders between the different types of educational environments have become ever more blurred. The quality of the participation in formal education is therefore closely linked to the quality of the informal educational environment in which an individual participates and vice versa. For example, research (Lee & Barro, 1998) suggests a very strong relationship between features of the educational environment of the home, such as parents' level of education, and the performance of children in formal education. Parents and the informal educational environment they provide is thus a critical qualitative feature of the educational outcomes in formal education. This has become particularly pertinent as a result of the introduction of ICT, since these technologies can potentially allow for greater interaction between the formal education that takes place in schools and the learning that takes place in the home. There is thus an increasing utilisation of electronic educational tools in schools and, perhaps more importantly, an expectation of greater utilisation of electronic educational tools by students at home. The extent to which formal education can be transformed to incorporate electronic learning tools may therefore be dependent upon the degree to which students can make use of electronic learning tools at home. A conceptualisation and operationalisation of human investment in the era of the New Economy must therefore take account of the relationships between formal, informal and non-formal education, and the potential intensification of these relationships as a result of the introduction of ICT.

Moreover, the different education environments are not of equal relevance throughout an individual's life. Accordingly, it is necessary to establish the different periods in a person's life that the various educational environments are applicable. In the same way that there is an established typology of educational environments we can thus ascertain periods in people's lives when the different educational environments are relevant, and how they relate to each other during each period.

In order to do so it is important to distinguish between an informal educational environment for children living in a family home whilst enrolled in formal education, and the informal educational environment that facilitates learning for adults whilst taking part in non-formal education at their workplace. Consequently, the relevant informal educational environment is dependent on an individuals age, and rather than

thinking of informal education environments as uniform, it is useful to separate the informal dimension of lifelong learning into two periods of an individuals life. Period 1 is the time during which the individual lives with his or her parents/guardians. The informal educational environment in period 1 is shaped by the parents/guardians rather than the individual, and interacts with the individual's participation in formal education during this period.

The second period is the time during which the individual is an adult and has his or her own household. Shaping the informal educational environment during this period is done by the individual whilst he or she participates in various forms of non-formal or formal education. The informal educational environment for individuals in period 2 thus exists in interaction with the non-formal and formal educational environments available in society. In sum, we have the following two periods of human investment:

Period 1 constitutes the time during a person's life, where participation in formal education and residence in parents/guardians home are the most important educational environments that generate human capital. These two educational environments may become more closely tied together as a result of the introduction of ICT for human investment purposes. Individuals can now access formal education services in the informal educational environment of their home, if the necessary qualitative features are present. The opportunities for integrating the human investment that takes place in formal and informal educational environments in period 1 have therefore been enhanced.

It is perhaps worth noting that given the importance of parents and the quality of home and school, period 1 highlights the cumulative effects of human investment efforts upon subsequent generations. Such externalities mean that the human investment that takes place during period 1 is not solely justified by its immediate impact on the productivity of the recipient, but can be justified by reference to its long-term impact on future generations as well.

The non-formal education environment plays a minor or no role during period 1. After school work may be relevant for some people in period 1, but is scarcely significant for the human investment during this part of an individual's life.

Period 2 is the time when the educational environments are primarily made up of a person's workplace and the own home of that individual. The most relevant

educational environments are thus the non-formal workplace and the informal household. Again, the two educational environments are becoming increasingly integrated, with the borders between office and home becoming increasingly blurred. In addition, while formal education has traditionally not played a significant part for individuals in period 2, the more rapid pace of technological innovation may make adults increasingly turn to formal educational institutions for human investment provision. However, it is likely to play a far less significant role than in period 1.

Furthermore, the two periods are interrelated. The human investment opportunities available to an individual in period 2 are dependent upon the education received during period 1. Human investment during period 1 is therefore also justified by its effect on subsequent human investment efforts.

The framework of lifelong learning can be illustrated as follows:

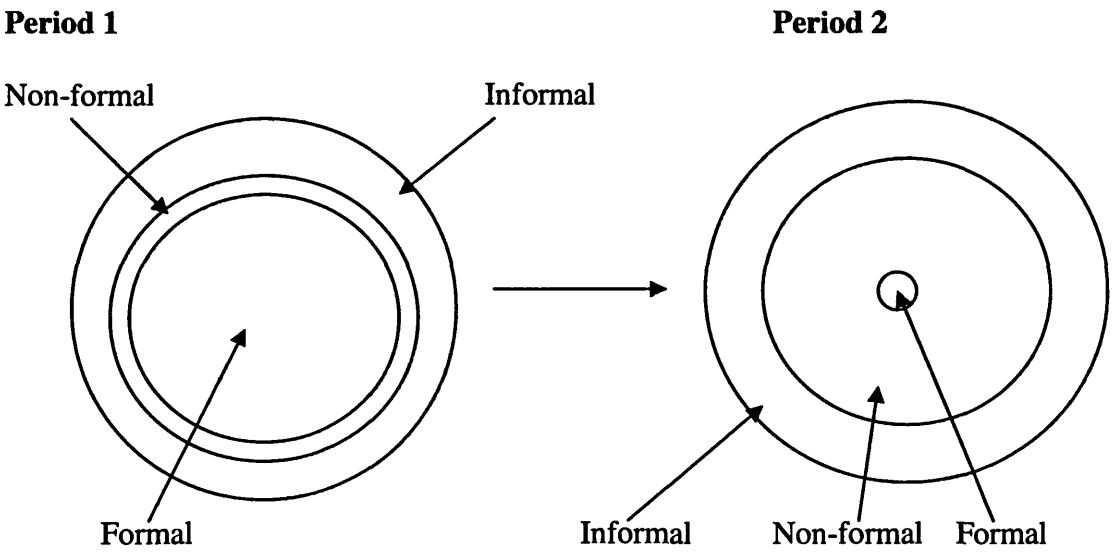


Figure 1

As can be seen from the figure above, the educational environments are not only different for each period, but they are of different relevance as well. During period 1 the human investment will predominantly take place in the formal and informal education environments, with the non-formal education environment playing only a minor or no role. During period 2, human investment is primarily achieved through the non-formal and informal education environments, with formal education playing only a minor role. The operationalisation of human investment which follows will

reflect these differences in importance of each educational environment for the two periods. Accordingly, the majority (if not all) of the indicators for period 1 should aim to capture human investment in the formal and informal education environments for this period, while the majority (if not all) of the indicators for period 2 should aim to proxy human investment in the non-formal and informal education environments relevant for this period.

Accordingly, we are seeing a marked shift in the nature of human investment, as the providers and users of education and training adapt to the new challenges of the New Economy. This 'creative destruction' process in the human investment sector is a direct response to the wider creative destruction process of the economic and social fabric resulting from the emergence of ICT and the New Economy. The emergence of lifelong learning should thus be analysed as inextricably linked to, and a significant part of, the New Economy. Indeed, it could be argued that with the emphasis on intangible human capital as a catalyst of the New Economy, the transformation of human investment itself is of crucial importance if countries are to fully exploit the productive potential of ICT. In the chapter that follows, the development of the conceptualisation and operationalisation of human investment will be taken further with the specification of a number of relevant variables.

Chapter 4

From conceptual framework to specification of variables

4.1 Introduction

In the previous chapter it was argued that the emergence of the New Economy has a number of implications for our understanding of human investment. How, when and where human investment is required to and can take place during an individual's life is increasingly changing. These changes are captured in the concept of lifelong learning. It is the objective of this chapter to specify the variables of relevance for a comprehensive operationalisation of human investment.

4.2 Stakeholders and levels of aggregation

The two periods outlined in the previous chapter constitute the main pillars of the new human investment framework emerging through the creative destruction processes of the New Economy. However, the Schumpeterian approach to human investment and technological change adopted in this project has so far only examined the wider implications of ICT for the economy and human investment provision. Yet, Schumpeter himself stressed that technological development and social and economic change should not be considered an automatic process. Rather, these changes are subject to the actions of social and economic actors in a dynamic environment. The emergence of the new dimensions to human investment cannot, therefore, be considered a given. These are subject to complex transformations of society and organisations and changes in the activities of individuals. These transformations are themselves part of the process of technological change in modern capitalist societies. Hence, while the New Economy presents us with a number of new challenges and opportunities with regard to human investment, the availability of learning opportunities in new improved educational environments is not a given, but subject to a number of changes at the macro, meso and micro level. Hence, the actions of individual actors cannot be understood in isolation, but must be contextualised at the meso and macro level. In this section, the changes at the macro, meso and micro level

for each period will be conceptualised in greater detail. In addition, the first steps for an operationalisation of the conceptual framework will be taken by specifying the relevant variables for a comprehensive operationalisation of the education environments and stakeholders of each period.

4.3 Specifying the core variables for the education environments and stakeholders

4.3.1 Period 1

The education and training which takes place during period 1 has been the primary focus of analysis of human investment in capitalist economies. The education environments of this period are therefore not new dimensions of human investment arising out of the emergence of the New Economy. However, the widespread introduction of ICT for learning purposes has the potential of transforming and improving the processes of learning in all educational environments during this period. However, in order for these changes to take place, adaptation at all levels of aggregation is required. In the following, the new dimensions to human investment during period 1 will be outlined.

4.3.1.1 Macro-level

The macro-level at period 1 refers to the commitment by government to education and training for people in this period. The opportunity for individuals to partake in learning activities is dependent on the public commitment to education and training for individuals in period 1. Indicators that reflect the public commitment to education and training for people in period 1 are therefore needed. In particular, the public commitment to introducing new learning technologies is of importance to the transformation of human investment provision in period 1. The ability of schools and individual learners to acquire and make use of new learning technologies is dependent upon the public commitment to introducing the new technologies in the education process. Such a commitment is reflected in the allocation of resources towards the introduction of new learning technologies in the formal and informal education environments.

In addition, it is important to examine the institutional processes in place for human

investment. An examination of resources devoted to education is insufficient as a measure of human investment, since these resources are inevitably mediated to individual learners through complex institutional processes and organisational structures. The nature of these processes and structures is itself an important aspect of the human investment provision within a country. Hence, the overall amount invested in education says nothing about how the resources are invested. This latter question will be determined by the nature of the education system. For example, access to formal education will depend upon whether there is a clear objective of inclusion in the education system. Such institutional factors will to some extent be reflected in participation rates in formal education. Such participation rates also capture how much society is investing in human capital as measured by the time devoted to human investment, as opposed to the financial resources measured by expenditure data. Similarly, it is important to acknowledge differences in the human resources devoted to facilitate learning in the formal education environment. Differences in the availability of teacher resources must therefore also be taken into account.

Variables include:
Public and private investment in period 1 education
Expenditure on ICT for formal education
Participation in formal education environment
Teacher resources (quantity and quality)

4.3.1.2 Meso-level

The operationalisation of the meso-level in period 1 will focus on the institutions providing formal education. Significant changes are taking place at the meso-level in period 1 as a result of the introduction of ICT for learning purposes. In particular, new means of structuring teaching are emerging as a result of ICT. Consequently, teachers and school leaders have to adapt their human investment provision to the new learning technologies. This requires not only the introduction of new technologies but also the training of teachers in the use of the technologies and inclusion of the new technologies in teaching practices and curricula (Roberts et al, 2002).

BEEP (2003) highlights three areas in which schools have to act in order to be able to fully exploit the potential for learning of ICT:

- Establish, improve and increase the IT infrastructure and digital learning materials
- Ensure teachers have the necessary skills to make use of the new learning tools
- Create new methods and processes of teaching and learning

(BEEP, 2003)

The introduction of ICT as a learning technology thus gives rise to a number of challenges for the school as an organisation. As with corporations and firms that are faced with the challenges of the New Economy, so the organisational adaptability of formal education providers is critical for the transformation of human investment provision. Such organisational change is by no means a given, but requires the concerted efforts of school leaders and staff.

Variables include:
ICT resources
Human investment in teachers
Use of ICT by teachers
Availability of digital learning materials

4.3.1.3 Micro-level

The micro-level refers to the activities of the individual learner in the formal and informal education environments (The non-formal education environment is not sufficiently significant for the human investment during period 1 to merit further investigation). The access to and use of new learning technologies will be of particular interest. This is true for both the use of ICT in the home and the school.

Formal education environment:

With the transformation of the formal education environment, students will now have the opportunity of participating in a number of new learning activities related to the utilisation of ICT (Harrison et al, 2002). However, the availability of ICT in schools and use of the new technologies by teachers does not make the use of ICT by students a given. The transformation of learning in period 1 therefore also requires changes to the activities of individual students. Indeed, the proper integration of ICT in formal education will include the participation of students. A full analysis of human investment in the formal education environment should therefore also include the activities of the individual learner with respect to the new learning technologies.

Variables include:
Use of ICT by students in school
Use of Internet by students in school

Informal education environment:

The opportunities for learning in the informal education environment are becoming enhanced by the introduction of ICT. However, the extent to which the informal education environment facilitates learning will be dependent upon a number of factors. Education research has shown how household factors are critical in determining education outcomes. In particular, the role of parents has consistently been shown to be one of the most important factors in explaining educational success (Lee and Barro, 1998). With the introduction of ICT in schools and the household for learning purposes, the relationship between school and the home is becoming of even greater interest. As with the formal education environment the introduction of ICT in the informal education environment does not in itself ensure its use for educational purposes in the household. Rather, a number of characteristics of the household will determine how much and in what ways ICT is being used by children. Access to ICT may therefore not be the primary concern, but rather the use of the new technologies for education purposes. A recent report by Somekh et al (2003) for the UK Department for Education and Skills noted that "since the majority of pupils have access to computers in the home, and most other pupils can get access in other ways outside school time, the more serious problem appears to be differences in the use of available computers. These appear to depend on family values and choices made in the home about the kind of computer use that pupils engage in" (Somekh et al, 2003:6).

Variables include:
ICT resources in the home
Internet availability in the home
Use of ICT and Internet in the home

4.3.2 Period 2

The New Economy presents a number of challenges and changes to the way in which

human investment is provided for individuals in period 2. While learning during this period is not a new phenomenon, the emergence of the New Economy and the concomitant acceleration in technological innovation generates an increased demand for human investment during period 2. Furthermore, the introduction of ICT for education and training purposes gives rise to a number of new opportunities for human investment during this period. In order to gain a clearer understanding of how human investment during period 2 is being transformed, it is necessary to explore the impact of the Schumpeterian creative destruction processes at the different levels of aggregation.

The efforts to analyse the learning taking place during period 2 have often built on the long-standing tradition of measuring education and training during period 1. Many of the methodological approaches used for period 1 have thus provided the foundation on which methodologies for period 2 have been developed. However, while both periods are critical for the overall human investment measured in a country, it is important that the methodologies used for period 2 take account of the particular contexts and type of learners unique to this period. While some of the same methodological challenges and problems are shared between the two periods, each period has its own conceptual and operational characteristics which need to be taken into account. In particular, the context of the labour market and the workplace, and the fact that learning in period 2 is done by adults, has significant implications for our understanding and operationalisation of human investment during period 2. Hence, in period 2 the majority of learning is not taking place in institutions or organisations dedicated to the purpose of learning. Rather learning in the non-formal education environment is undertaken as part of the wider objectives of the organisations in which individuals work. One methodological implication of this difference is that rather than examining organisations as a whole (as can be done of formal institutions of learning) we need to examine how organisations integrate learning in their operations and business practices. As a result, the learning that takes place in the non-formal education environment of period 2 cannot be measured in accordance with clearly defined curricula, but rather as how processes of learning are integrated into the processes of work.

The problem is that many attempts at analysing period 2 have developed indicators of how closely the non-formal and informal education environments resemble the formal education environment of period 1, rather than examining how the particular context of the non-formal and informal education environments of period 2 facilitate learning. This creates an unwarranted focus on adults' participation in dedicated periods of training or education similar to that of the formal education environment during period 1 and neglects the ways in which learning can be incorporated into the processes of work. Rather, the methodology used for analysing period 2 should take account of the specific characteristics of the learning that takes place in the non-formal and informal education environments. This is not to say that dedicated periods of training are of no importance to the human investment undertaken during period 2. However, the fact that learning is done by adults and in contexts such as the workplace suggests that we need to look more carefully at how learning is integrated into the environments in which adults live and spend their lives. Accordingly, a more nuanced approach, in which the education environments of period 2 are studied in greater detail, is called for. In particular, the features of the working environment which facilitate learning for the employee are of relevance, and need to be specified as variables.

Furthermore, the analysis of period 2 needs to take account of the fact that the learning here is done by adults. The methodological implications of adult rather than child learning are manifold. This is reflected in the growing literature and theories of adult learning. The literature on adult learning grew out of a concern that the available theories of learning were developed for the needs of children, and that the application of these theories to adult learning was inappropriate (Tusting and Barton, 2003). Theories of adult learning emphasise the importance of the different context and situation in which adults learn as compared to children. In addition, the emphasis has been on the different objectives and reasons for undertaking learning by adults. Indeed, it is much more difficult to establish a clearly defined outcome for adult learning, while the education and training of children is structured within the confines of formal institutions of education with curricula.

A dominant theory of learning for adults has been the theory of andragogy. This

theory highlights the importance of self-direction in adult-learning, and the allowance for learners to build on their own experiences (Knowles, 1973 and Knowles et al, 1998). "Knowles claimed that adults have to know why they need to learn something before they undertake to learn it. They must move from a dependent self-concept to a self-directing one. They have accumulated more experience, and experiences of a different quality, than children and their readiness to learn is linked to the tasks associated with their social role and stage of life. Adults engage in problem-centred, rather than subject-centred learning and are driven by internal rather than external motivation." (Tusting and Barton, 2003:19). Hence, it is important to ascertain the context in which adults learn and the extent to which adults themselves perceive a need to learn. This will, for example, determine the extent to which adults will make use of new technologies for learning purposes at work or in the home.

Moreover, in period 1 children and young people learn in a clearly structured educational environment with clearly defined objectives, pace and methods of learning. Accordingly, we can measure the human investment provision of period 1 by establishing the quantity and quality of learning in relation to the defined objectives, pace and methods of learning. In contrast, theories of adult learning suggests that the individual learner in period 2 needs to have greater autonomy and be in greater control of the objectives, pace and methods of learning (Tusting and Barton, 2003). Furthermore, the learning of adults is said to be situated within the particular context of the individual adult (Lave, 1988 and Rogoff and Lave, 1984). We therefore have less clearly defined benchmarks against which the quantity and quality of learning can be measured. Consequently, the measurement of learning must be based on the objectives, pace and methods set out by the individual learner. More specifically, we cannot use measurements for period 2 applying the same objectives, pace and methods of learning as used for period 1. This presents us with a formidable methodological challenge. In particular, we need indicators that take far greater account of the objectives and structure of learning set out by the individual learner. Moreover, we need to take account of how the workplace facilitates learning in accordance with these objectives and desired pace and methods of learning. The combination of greater variety in objectives and means of learning with the greater diversity in workplace contexts represents serious methodological problems when

attempting to construct valid and reliable indicators for comparison of countries. The particular difficulty lies in creating indicators which can satisfactorily take account of the diversity of learning that takes place during period 2, whilst also provide reliable results for comparison and benchmarking.

The argument developed above suggests that the specification of variables for period 2 is a complex process, which needs to take account of a number of new aspects of the New Economy. The change towards lifelong learning has significant implications for the individuals, organisations and the wider labour market. The changes at all levels of aggregation need to be specified in variables for the operationalisation of human investment in the era of the New Economy.

4.3.2.1 Macro-level

The macro-level for period 2 refers to the societal context in which adult learning takes place. For example, to what extent is there public commitment to adult education and training? This will be reflected in the expenditure on adult education and training. However, given the more complex context of period 2, the commitment and expenditure may take a number of different forms. One opportunity is direct expenditure by the public sector. More indirect measures would include subsidies to employers for human investment purposes or a regulatory framework that obliges employers to train their employees. The different means of public commitment are likely to lead to different learning outcomes, and indicators should reflect the different means of commitment.

In addition, the specification of variables for a labour market which can accommodate lifelong learning is an important part of the operationalisation of the macro-level for period 2. At first glance this may not seem a significant issue for the successful implementation of the lifelong learning strategies of the European Union. Nevertheless, rigidities associated with narrow professional classifications based on qualifications acquired from participation in formal education may prove a significant obstacle to the implementation of flexible learning organisations and the creation of non-formal and informal education environments for individuals in period 2. A labour market for lifelong learning can no longer rely on the formal education environment

to develop and allocate workers into different professions. For example, in Germany "the Beruf concept is seen to be both an internal barrier [to learning organisations and human resource development in the workplace], preventing workers from taking on new tasks, and also an external barrier that restricts peoples' room for manoeuvre because their occupations are defined in relation to a limited number of work tasks and are bound by rather rigid qualification and remuneration systems" (Nyhan et al, 2003:75). Rather, there has to be greater flexibility and a system in place that does not solely rely on the formal education system for information on the availability of skills among the labour force (Tørnæs et al, 2004). In order for such a transformation to take place, employers need to change their recruitment and promotion procedures, and other stakeholders in the labour market adjust the requirements for membership of professional bodies. The labour market thus needs to be 'constructed' in recognition of and such as to accommodate the increasing need for lifelong learning. Having clearly defined professions based on formal qualifications is a labour market structure appropriate for a stable industrial economy but not suitable for a dynamic New Economy characterised by perennial change.

Variables include:
Public commitment to period 2 education and training
Structure of labour market conducive to lifelong learning
Labour market rigidities impeding learning in non-formal and informal education environments

4.3.2.2 Meso-level

The meso-level refers to the learning taking place in or provided by organisations and firms to their employees. This part of the framework of lifelong learning has become of increasing importance with the emergence of ICT, and the challenges brought about by the New Economy.

Within the Schumpeterian creative destruction processes of the New Economy, the adaptability and transformation of organisations is of great significance. As the innovative activities of organisations shape technological progress, so these very same organisations have to adapt to the changing economic and social landscape resulting from the technological innovations. Dosi and Malerba (1996:9) argue that organisations operate within a technological paradigm which shapes "'modal forms' of technological learning and 'modal types' of organizations suited for those learning

patterns". The technological environment will define the nature of the problems an organisation has to solve, the constraints and incentives facing an organisation in their operations and the dynamic mechanisms of the evolution of firms and industries. The organisation of firms and technological development thus go hand in hand.

The emergence of the New Economy and ICT as a General Purpose Technology has had significant implications for how organisations are structured and how they operate. The accelerated pace of technological innovation and diffusion has made the survival of an organisation increasingly dependent on its ability to implement processes of continuous improvement, embedded in the workplace and the organisation. Castells (2001) links the changes to context and organisation in the information society as follows:

> "Productivity and competitiveness are, by and large, a function of knowledge generation and information processing: firms and territories are organized in networks of production, management and distribution; the core economic activities are global – that is they have the capacity to work as a unit in real time, or chosen time, on a planetary scale" (Castells, 2001:52).

The changes to the socio-economic context thus forces firms to attend to the need for continually improving processes within the organisation as a matter of survival in the increasingly competitive market place in which knowledge generation and information processing is key. The same socio-economic changes that bring about the increasing need for lifelong learning thus set in motion a transformation at the meso-level of firms and corporations towards greater adaptability and flexibility. This has been captured in the notion of practice-based and organisational learning developed by Donald Schön (1983) and Peter Senge (1990). In contrast to former organisational structures where competitiveness was achieved through scale in fairly stable market conditions, the New Economy rewards the ability to adapt to and exploit new technologies and production processes for competitive advantage. This places extra emphasis on the improvement in competences of the workforce and the organisation as a whole. Senge (1990:3) defines the learning organisation as follows:

> ...organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together.

In order to be flexible, adaptive and productive, organisations need to "discover how to tap people's commitment and capacity to learn at *all* levels" (Senge, 1990:4). Moreover, in order to avoid organisations being stuck in routines and practices which obstruct the adoption and utilisation of new technologies and production processes "there is also a need for learning strategies that focus on 'unlearning' previously established ways of doing things" (Davies and Nutley, 2000:3). This issue is further reflected in Argyris and Schön's (1978) distinction of learning into three different levels. While single-loop learning refers to the incremental improvement in existing practice, double-loop learning refers to the process by which organisations rethink their paradigms and goals. Finally, meta-learning refers to the process by which organisations reflect on its ability to learn. A learning organisation will stand out in its ability for double-loop learning and meta-learning. In order not to be caught in obsolete routines, a learning organisation thus needs to facilitate double-loop and meta-learning. This places a great role, not only on the provision of training opportunities for employees, but an organisational structure and management style that gives employees the opportunity to reflect on and improve current practices. Senge summarises the requirements of the learning organisation as some basic disciplines or 'component technologies' which are "concerned with a shift of mind from seeing parts to seeing wholes, from seeing people as helpless reactors to seeing them as active participants in shaping their reality, from reacting to the present to creating the future" (Senge, 1990:69). Such an approach has significant implications for how companies are managed and led. Senge argues that "In a learning organization, leaders are designers, stewards and teachers. They are responsible for *building organizations* where people continually expand their capabilities to understand complexity, clarify vision, and improve shared mental models – that is they are responsible for learning" (Senge, 1990:340) The learning of individual employees is therefore not solely down to their own learning activities, but also a management style and leadership that facilitates learning within the organisation.

It is evident from the above that while Senge himself did not make the link between socio-economic change and the learning organisation, the relationship between lifelong learning and the learning organisation is critical for our understanding of human investment in the era of the New Economy. Period 2 can thus not be satisfactorily analysed without the inclusion of the learning organisation as a critical element.

However, in order to make the notion of the learning organisation analytically workable for the purposes of a subsequent operationalisation, it is necessary to specify the key aspects conducive to learning within an organisation. This is particularly difficult given the complex nature of the learning organisation. The concept 'learning organisation' refers more to processes within the organisation rather than an organizational state of being. Or put in a different way, the state of being a learning organisation involves continuous learning and adaptation in an attempt to influence the internal and external environment of the organisation. The state of being a learning organisation should thus be understood in an existential manner rather than a static position (Nyhan et al, 2003). "If an organisation, behaving in a smug and self-confident manner, considers that it has achieved the goal of being a learning organisation, it has ceased to be a learning organisation" (Nyhan et al, 2003:19). Accordingly, an analysis should capture particular processes of learning within an organisation rather than clearly defined outcomes. This suggests a need for indicators capturing the dynamics of organisational processes rather than outcomes of these processes, representing a significant methodological challenge.

Furthermore, a difficulty in the operationalisation of the learning organisation is the importance of intangible cultural features of the organisation, rather than tangible structural features and everyday working routines. Indeed, the literature on the learning organisation emphasises the priority of the intangible cultural dimensions over the tangible structural features and work routines. This is not to say that the tangible, and more readily measurable, features of the organisation are unimportant. "But, the important thing about building these structures and work routines is that they have to be aligned with the shared aims, understanding and values of all the members of the organisation. The structure gets meaning from the organisation's

cultural mind-set and lived practice" (Nyhan et al 2003:45). Rather than seeing the learning organisation as a single template which can be implemented across organisations, the learning organisation "is a 'socially constructed' reality that must be built and continuously sustained through developmental processes that involve all the actors in an organisation. The aim is to generate shared meanings derived from the discourse and lived practice of a company rather than applying a theory or a structural template" (Nyhan et al, 2003:44).

However, while it is difficult to ascertain the exact features of the working environment stimulating learning by the employee, a number of issues pertaining to work tasks and the work and learning context and environment have been highlighted (Nyhan et al, 2003). Fischer (2003) identifies the following key organisational characteristics:

1 Workers receive immediate feedback on work results
2 Adoption of the principle of self-organisation and self-control (autonomy for groups of employees to reorganise internal production processes)
3 Integration of work and learning
4 Sharing knowledge and experience within the company
5 Networking and benchmarking

(taken from Nyhan et al, 2003:67-68)

These more tangible prerequisites of the learning organisation can be specified into variables and operationalised as indicators, while the all important cultural dimension of the learning organisation is less easily proxied in quantitative data. The problem remains that the meaning and role given to the tangible features of the organisation is determined by its culture. The relevance and appropriateness of indicators of tangible features of the organisation is thus dependent upon the meaning given to these features by the organisational culture. This should be borne in mind when interpreting indicators of the learning organisation.

Variables include:
Employer commitment to human investment of employees
Employer expenditure on training of employees
Learning organisation features

ICT/Network resources in organisations

4.3.2.3 Micro-level

The micro-level refers to the activities of the individual learner in the educational environments of period 2.

Non-formal education environment:

This part of the framework of lifelong learning relates to the learning activities by individuals that take place through participation in the labour market. Of great importance, the transformation towards the learning organisation involves a number of changes to the activities of the individual employee. Ellstrom (2003) identifies the following characteristics of work in a learning organisation:

- High degree of task complexity – variety and control regarding the 'actions' being undertaken.
- High degree of task-relevant knowledge required – offering possibilities for personal development.
- Opportunities for feedback, evaluation and reflection on work undertaken that requires deliberation and choice.
- Possibilities for employee participation in shaping the design of the work environment and bottom-up collective learning, as distinct from more formalistic top-down and standardised approaches.
- Formal participation in problem handling and development activities.

(taken from Nyhan et al, 2003:65)

The first two points refer to the activities at work creating a need to learn by the individual employee, while the latter three points refer to the employees' participation in processes of management within the organisation. The two former points suggests that it is of interest to include variables of the extent to which individuals perceive a need to learn as part of their job, and whether they think the skills they have are being properly utilised in their work. The three latter points suggests that a comprehensive operationalisation of the learning organisation requires us to specify variables of the employee's participation in shaping their work and the organisation in which they

work.

Furthermore, in order to facilitate the processes of learning outlined above, the organisation must ensure that the employee has access to the networks of knowledge and information relevant to the employee's work. These networks can be more or less formalised and are sometimes referred to as communities of practice. These are "groups of people informally bound together by shared expertise and passion for a joint enterprise – engineers engaged in deep-water drilling, for example, consultants who specialize in strategic marketing, or frontline managers in charge of check processing at a large commercial bank. Some communities of practice meet regularly – for lunch on Thursdays, say. Others are connected primarily by e-mail networks. A community of practice may or may not have an explicit agenda on a given week, and even if it does, it may not follow the agenda closely. Inevitably, however, people in communities of practice share their experiences and knowledge in free-flowing, creative ways that foster new approaches to problems" (Wenger and Snyder, 2000:139-140). Accordingly, a critical part of employees' learning at the workplace is participation in such communities of practice.

The arguments presented above suggest that there is a special role for the workplace in the overall strategy of lifelong learning in the New Economy. This is particularly the case given the difficulty for adults to find time to participate in education and training away from the work and home, making it more appropriate to transfer the education and training to the workplace or home. In addition, the education and training taking place in a classroom can often be decontextualised and discontinuous, i.e. "the traditional classroom is just too far away from real work" (BEEP, 2003:1). Rather, the theories of adult learning imply that the education and training for people in period 2 should be 'situated' learning in the context of the tasks performed in the workplace (Suchman, 1996, Slavin, 1994, Erlich and Cash, 1994, Clark and Brennan, 1991). This would involve building learning into the processes of work or tie training closely to work-related tasks. ICT provides new opportunities for doing so. Khaira (2002) argues that there are three advantages for adult work-related learning brought about by the introduction of ICT:

1 Flexibility. ICT allows the employee to do the training when it is most fitting, at a pace most suitable to the employee.
2 Adaptability. ICT allows for the tailoring of learning materials to the particular needs and context of the employee.
3 Cost reduction. ICT allows for less face-to-face instruction, travel costs and time reducing the cost of training.

This is supported by Berg (1999) and Weintraub (1998) who have argued that the Internet has supported learning in environments such as the workplace. Accordingly, it is necessary to specify variables of the availability and utilisation of ICT in the non-formal education environment.

However, while the workplace and the introduction of ICT creates a host of new human investment opportunities, it is important not to neglect the increasing importance of traditional training provided fully or in part by the employer. Participation in training by employees thus remains an important variable for human investment provision in period 2.

Variables include:
Employee participation in training
Perception of use of skills by employees
Learning on-the-job and participation in communities of practice by employees
Use of ICT and Internet at work by employees

Informal education environment:

Education and training by individuals outside the context of work is also an important element of human investment. Of particular interest to this project, are the ways in which ICT is increasingly becoming a facilitator of learning in the home (Gorard et al, 2003). This is reflected in the increasing opportunities for self-directed learning using ICT as the mediating technology.

Variables include:
Participation in self-directed learning
ICT resources in the home
Internet access in the home
Use of ICT in the home
Use of Internet in the home

Formal education environment:

The increasing pace of creative destruction may require people who have entered the labour market to require formalised training or even temporarily leave the labour market and return to formal education. Furthermore, ICT allows adults to partake in formal education through distance learning in ways that were not possible before. Accordingly, while there are increasing opportunities for learning in the non-formal and informal education environments the formal education environment may play a role of increasing importance for people in period 2.

Variables include:
Adult participation in formal education/training
Participation in distance learning provided by formal educational institutions

The specification of the core variables is summarised in table 1 below.

Table 1

	Period 1 Formal	Period 1 Non-formal	Period 1 Informal	Period 2 Formal	Period 2 Non-formal	Period 2 Informal
Macro	Public and private investment in period 1 education Expenditure on ICT for formal education Participation in formal education environment Teacher resources (quantity and quality)			Public commitment to period 2 education and training	Structure of labour market conducive to Lifelong Learning Labour market rigidities impeding learning in non-formal education environment	
Meso	ICT resources Human investment in teachers Use of ICT by teachers Availability of digital learning materials				Employer commitment to human investment of employees Employer expenditure on training of employees Learning organisation features ICT/Network resources in organisations	
Micro	Use of ICT by students in school Use of Internet by students		ICT resources in the home Internet availability in the home Use of ICT and Internet in the home	Adult participation in formal education/training Participation in distance learning provided by formal educational institutions	Employee participation in training Perception of use of skills by employees Learning on-the-job and participation in communities of practice by employees Use of ICT and Internet at work by employees	Participation in self-directed learning ICT resources in the home Internet access in the home Use of ICT in the home Use of Internet in the home

The analysis and variables specified above provide us with information on the relevant features of human investment in the different education environments and at different levels of aggregation. As such, developing indicators for these variables will provide us with a more comprehensive picture of human investment provision than has hitherto been available. However, it was also noted in the analysis above that the different education environments coexist within the wider frameworks of period 1 and 2. Taking account of each of these periods involve more than merely specifying the relevant variables for each relevant education environment and level of aggregation. It was argued that each period constitutes a complex system of human investment provision in which the opportunities for learning in each education environment shape and interact with each other. Hence, it is necessary to ask whether the variables specified for each of the education environments and stakeholders are sufficient for the purposes of measuring and benchmarking human investment provision in the EU? Can the variables specified above provide us with the information necessary to make appropriate decisions on human investment? If a country is performing poorly on certain variables but better on others, should the policy response be to improve the less performing variable? Surely, the answer to this question is that policy makers should focus on the variables that provide most value in terms of human investment outcomes. Accordingly, we need to know something about the importance of the different variables specified above in shaping human investment outcomes. However, the importance of the various dimensions cannot be assumed to be similar across countries. Rather, having information on the differences in importance of each of the variables specified above is an important part of a comprehensive operationalisation of the conceptual framework developed.

4.4 Systemic variables

With the emergence of the paradigm of lifelong learning, there has been a shift from a common singular reference point for comparison (the institutions of formal education), to a multitude of reference points that may take on different roles in different countries. Accordingly, in specifying variables for the various features of the education environments and activities of relevant stakeholders, it is important to recognise that the role of each of these features and activities is mediated through a

wider institutional framework. While the availability of features facilitating learning in the relevant education environments is critical for human investment provision, this does not guarantee the access to or successful utilisation of such resources. Indeed, the manner in which the features of the different education environments, and efforts by various actors, contribute to human investment provision will be shaped by the interactions between education environments and the relationship between the framework of human investment provision and the wider socio-economic fabric. For example, the extent to which the variables specified for the informal education environment in period 1 contribute to human investment provision, will not only depend on their availability, but also the role they play in processes of human investment provision shaped by the institutional framework. In some countries it may be the case that ICT resources in the home plays a far more important role for learning than ICT resources in school. In other countries, the reverse may be the case. As much as the performance of countries in the various education environments and by different actors is likely to be different between countries, so it cannot be assumed that the institutional framework, and changes in this framework, through which the role of various features and activities are mediated are similar across the member states of the EU. Accordingly, it is important to recognise that the emergence of a more multi-dimensional framework of human investment provision across the EU may well lead to differences in the configuration of the overall human investment framework between countries. Having information about such differences is of great importance to policy makers, as it highlights further areas for possible intervention.

Two related methodological challenges emerge from this recognition. Firstly, different education environments and activities of the relevant stakeholders may take on different roles in different countries. Capturing such differences are important for a comprehensive operationalisation of the conceptual framework developed in the preceding chapter. Secondly, the education environments do not exist in isolation but interact, and the processes of transformation within one environment are likely to interact with processes of change in another education environment. Capturing such interactions are also an important element of a successful operationalisation of human investment in the era of the New Economy. Hence, the remaining part of this chapter will specify a number of variables which can inform us of how the multi-dimensional

framework is configured differently between countries, and how this manifests itself in different roles for different features of the education environments and activities by stakeholders.

In period 1 the formal education system and institutional framework underpinning human investment provision is different between countries, and such differences manifest themselves in different roles being assigned to different features of the relevant education environments. For example, the role of ICT in the home may be more important than ICT resources in schools in some countries, while the reverse is true in others. This will in part depend on how ICT is used, and how the education system facilitates access to and use of the new ICT learning tools. Accordingly, for each of the variables specified above for the meso- and micro-level of period 1, we need a further set of variables indicating their relative importance for human investment provision in the different countries. Furthermore, it is necessary to establish how important the new features are in relation to other more traditional features of human investment provision. Hence, we should not forget that reserach suggests "that parents' own education, and their involvement in learning and school, are factors that are just as important in improving their children's educational achievement as home ownership of ICT" (Somekh et al, 2003:11).

> Variables include
> Indicators of the importance of the variables specified for each of the education environments and stakeholders of period 1 in the section above

In period 2, similar issues are of relevance. For example, the extent to which the employer or employee is the most efficient at facilitating human investment will depend on the particular incentives and obstacles facing each stakeholder in the given economy and society. Accordingly, there will be a set of variables for period 2 similar to that of period 1, which will inform us of the relative importance of the various variables specified above.

> Variables include
> Indicators of the importance of the variables for each of the education environments and stakeholders of period 2 in the section above

Acknowledging that the different education environments do not exist in isolation and recognising that human investment at any given point in time of an individuals' life is shaped by interactions between education environments means that capturing such interactions is an element of a comprehensive operationalisation. Indeed, of particular interest are the new opportunities to create links between education environments in the relevant periods arising from the introduction of ICT as a learning tool. This is likely to mean that the introduction of ICT will have wider effects on the human investment framework, and reshape the role of other features of the education environments.

For example, the opportunities for greater interaction and establishment of educational networks between school and home facilitated by ICT "may place greater reliance upon parents' involvement to support their children's learning and that, rather than overcoming social disadvantage, [ICT] might only reinforce existing inequalities in levels of parental involvement. Given the differences in parents' level of ICT skills, this problem may be reinforced when ICT becomes an important component of learning at home as well as in school" (Somekh et al, 2003:11). Accordingly, the emergence of ICT as a new learning tool for both the formal and informal education environments in period 1, is likely to transform the overall human investment framework and have wider ramifications for the relative role of other features of both the formal and informal education environment. In other words, the introduction of new means of learning do not merely add to existing features of the education environments, but reshape the human investment framework in its entirety. Consequently, there is a need to operationalise and measure such changes, in order for policy makers to be able to track changes in human investment provision.

> Variables will include:
> Relationship between ICT availability in home and school
> Change in role of other features of the formal and informal education environments resulting from the introduction and utilisation of ICT in the relevant education environments (e.g. change in the role of socio-economic status, parents' education and teacher resources resulting from the introduction of ICT)

In period 2 these interactions are also becoming more important. This is reflected in the growing debate on the eradication of barriers between the home and workplace

(Sproull and Kiesler, 1992). As the demarcation between the work and non-work environments is becoming less pronounced, the role of each place in human investment provision is transformed. The learning that is taking place in period 2 is thus likely to be a product of interactions between activities in he various education environments. For example, as ICT is introduced, the role of the informal education environment may become more pronounced as it allows for learning and work activities to increasingly be transferred to the home. Alternatively, the features of the non-formal education environment may become more important as the features of the workplace feed into the informal education environment. Moreover, with the emergence of distance learning, and new forms of links between the individual learner and formal education environments, the interactions between the formal education environment and the non-formal and informal education environments may become more important.

Variables will include:
Relationship between the availability and use of ICT in the non-formal, informal and formal education environments
Reshaping of the role of various features of the non-formal and informal education environments resulting from the introduction of ICT.

4.5 Conclusion

In conclusion, the emergence of lifelong learning as the dominant paradigm of human investment provision has a number of methodological implications which an operationalisation must take account of. Firstly, the measurement and benchmarking of the multi-dimensional framework of human investment must take account of the new dimensions of human investment provision, with due consideration of the unique characteristics of learning within each dimension of the framework. Secondly, with several dimensions of human investment provision, different configurations of the overall framework may emerge, with different dimensions taking on different roles and interactions of different forms between dimensions emerging in different countries. Measuring such differences in the overall configuration of the human investment framework is a critical methodological challenge for a comprehensive operationalisation of human investment in the era of the New Economy. In combination, these methodological challenges introduce a number of new variables that require measurement. In the chapters that follow, statistical indicators that proxy

the variables specified in this chapter will be identified, developed and presented. In chapters 5 and 6, the indicators for the core variables specified in the first part of this chapter will be developed and presented. This will be followed in chapter 7 with the development and presentation of a more complex set of indicators intended to proxy the systemic variables specified in the latter part of this chapter.

Chapter 5

Stocktaking of data sources

In the previous chapter the first steps of an operationalisation of human investment were taken. The result was the specification of a number of relevant variables for which indicators need to be developed. These were presented in a table, structured in accordance with the different periods, education environments and levels of aggregation. The objective of this chapter is to review the available data for the construction of indicators for each of the core variables specified for the different education environments and levels of aggregation summarised in table 1 of chapter 4. In the chapters that follow, the operationalisation will be continued with the construction of scorecards of quantitative indicators for each country with the available data, covering the different dimensions to human investment specified in the previous chapter. Interestingly, the use of scorecards is increasingly being applied to empirical investigations and benchmarking of intangibles in economic and social analysis such as to complement the extensive information available on more tangible assets. This is particularly the case in the area of knowledge management for organisations (Kaplan & Norton, 1996). Given the intangible and multi-dimensional nature of many of the new human investment processes, a similar method is chosen for this project. In order to conduct such an operationalisation it is first necessary to take stock of the available data. This chapter will provide an overview and appraisal of sources that contain relevant data for one or more of the variables of human investment specified in the previous chapter. The chapter is separated into two sections, one for each period of the conceptual framework. The first part of each section will be a discursive evaluation of the methodological approaches adopted for the operationalisation of the various dimensions of human investment by a number of different sources. This will be followed by a number of tables for each period giving a more detailed appraisal of available data for each of the variables outlined in the previous chapter.

5.1 Period 1

Period 1 has been extensively covered by international data sets. Organisations such as OECD and Eurostat have long collected comparable data for formal education for all member states. However, the majority of the data collected relates to the formal education environment, while only recent surveys have begun to explore the informal education environment in greater detail. In addition, the new opportunities for learning arriving from the introduction and utilisation of new educational technologies have only recently begun to be explored more rigorously. While extensive data on the availability of ICT and the Internet have been collected, the predominant problem has been the operationalisation of the use of these new learning resources, and how the educational process in both the formal and informal education environment is being transformed with the widespread introduction of these new technologies. This reflects the wider problem of measuring the processes of technological change, which requires the utilisation of new technologies in order to lead to improved outcomes. As noted in the previous chapter these processes are likely to lead to new educational infrastructures and relationships between the educational environments relevant during period 1. The primary challenge for a full operationalisation of period 1 is the definition of indicators that can satisfactorily account for these changes in processes of human investment. For example, the Eurobarometer Surveys and PISA study by the OECD have explored the issue of use in greater detail. However, while they manage to say something about the extent of use, capturing the way in which the new technologies are used, e.g. for rote learning or new pedagogical methods, has remained elusive for the official data sources.

A further and related problem with the data sources on the new educational technologies for period 1 is the emphasis on the availability of hardware to the exclusion of data covering investment in and use of software. This represents a potentially significant problem for the operationalisation of new educational practices in formal and informal education environments for people in period 1. The ways in which hardware can be used for educational purposes, and the pedagogical change the new technologies engender, are very much dependent on the availability of appropriate educational software. Placing a number of computers in a classroom may merely further a process of rote learning rather

than enable interactive self-guided learning by a student, if no suitable software is made available. Consequently, the emphasis on indicators covering the quantity of hardware available to students may give only a small indication of the extent to which ICT is being integrated into new educational processes in the formal and informal education environments. This suggests that not only the quantity but also type of software is of significant relevance to our understanding of the use of ICT for human investment purposes. The issue of software is closely related to the problem of measuring content. If information and knowledge are becoming increasingly available through the developments in ICT, it would be desirable to have measures of the information and knowledge available. More specifically, it is of interest to know whether there is educational content available for people making use of ICT in the different educational environments. Little is so far known about the appropriate methodological approach to be used for the construction of indicators measuring content. Measures of e-learning have predominantly focused on the availability and use of hardware.

In the tables below, the best available indicators for the core variables specified for period 1 in the previous chapter have been identified from the data sources that have been taken stock of. Furthermore, the strengths and weaknesses of each of these indicators are commented upon. It is evident from the tables that the stocktaking of data sources for period 1 reveals sufficient data for measurement of all the dimensions of the framework. However, for some of the variables of the various dimensions, there is a lack of satisfactory data. Notably, it would be useful to have better indicators measuring how ICT is being used by teachers and pupils for learning purposes, and how the utilisation of ICT is transforming processes of learning and pedagogy.

Table 1 Period 1 macro-level

Variable	Source	Indicator	Comments
Public commitment to formal education	OECD	Public and private expenditure on formal education as % of GDP	Provides a good proxy of the extent to which society prioritise and allocate resources towards formal education. Includes private expenditure to take account of the fact that the private provision of resources may constitute a relatively larger part of overall expenditure on formal education in some countries compared to others.
	OECD	Public expenditure on formal education as % of GDP	Provides a good proxy of the extent to which governments prioritise and allocate resources towards formal education. However, given the increasing presence of private schooling in some countries, this may become a less satisfactory indicator of the public commitment to formal education in the future.
Participation in formal education	OECD	Enrolment rates in primary, secondary and tertiary education	These indicators are often used proxies of participation in formal education. They give a good overview of participation in different levels of formal education. However, given significant differences in the systems of formal education across the EU, the comparability of these indicators is questionable. For example, the definitions and types of primary, secondary and tertiary education may differ greatly between countries. Hence, the indicators may not provide a satisfactory picture of participation in formal education in period 1 across the member states of the EU.
		Students aged 5-14 as % of the population of 5-14 year olds Students aged 15-19 as % of the population of 15-19 year olds	These two indicators provide a better estimate of enrolment rates than the one for primary, secondary and tertiary education, as they make use of the universal reference point of age rather than the institutions of formal education. Nevertheless, the age span for each group is rather large, and the indicators could have been improved if the indicators had been broken down to smaller age groups.
		Estimated number of years in formal education for a 5-year old child	This will give a good indication of the differences in participation across countries. Using average years of schooling, rather than categories of primary, secondary and tertiary education, takes account of the differences in the structure of education between countries. However, to what extent this represents a better measure of participation than mere enrolment rates is debatable. Indeed, by grouping all formal education together, the indicator does not illuminate enrolment at different levels of education or of different age groups. The indicator does therefore not provide as nuanced a picture of participation in formal education as the indicators above.

Period 1 macro-level (continued)

Variable	Source	Indicator	Comments
Teacher resources	Eurobarometer	Teacher/pupil ratio	Allows for an estimate of the human resources devoted to formal education. Moreover, the data allows for the construction of an indicator for the education system as a whole, but also broken down into primary, secondary and professional/technical education. However, the data does not specify whether teachers work part or full time. This represents a significant limitation when operationalising teacher resources with data from this survey.
	PISA	% of full-time teachers with ISCED5 in ped. or fully certified	Gives an indication of the quality of the teacher resources available in schools. Coupled with the data on the quantity of teacher resources, the indicator is a useful proxy of the teacher resources in formal education. However, a critical weakness of the indicator is that it relies on a common standard of education and training of teachers as a reference point for comparison. Teacher training takes on a number of different forms in different countries, and this indicator does not satisfactorily take account of these differences. Accordingly, there are clear problems of comparability associated with the use of this indicator as a proxy for the quality of teacher resources. Moreover, the PISA data set only covers secondary schools and is therefore not as representative as the Eurobarometer data.
Expenditure on ICT for formal education			No satisfactory data available.

Table 2 Period 1 meso-level

Variable	Source	Indicator	Comments
Human investment in teachers	Eurobarometer	Percentage of teachers who have received official training for the use of computers in their teaching	Provides a good proxy for the extent to which schools facilitate the integration of new learning tools into the teaching activities. However, there is no data on the quantity of training received or how frequently training is provided. While the data allows for an operationalisation of human investment in teachers specifically for ICT and the Internet, the data is rather weak on the extent of human investment.
		Percentage of teachers who have received official training for the use of Internet in their teaching	Same strengths and weaknesses as the indicator measuring official training for the use of computers in teaching.
	PISA	Percentage of teachers who have received professional training during the 12 months prior to the survey	Allows for an approximate measure of the efforts within the school to invest in teachers. However, the data does not specify the purpose of the professional training nor the quantity of training received. Moreover, since the PISA study is focused on schools with 15 year olds, the sample is worse than that for the Eurobarometer survey.

Period 1 meso-level (continued)

Variable	Source	Indicator	Comments
ICT resources in formal education	PISA	Pupil/computer ratio	Provides a good indication of the ICT resources in schools. However, the indicator does not take account of the extent to which the computers are actually made available to pupils or teachers for education purposes. Moreover, no account is taken of differences in the quality of the computers.
	PISA	Average availability of computers at school for students' use as measured by students' ranking on a scale from 1-5 where 1 is almost every day and 5 is never	It could be argued that this indicator provides a better proxy of the availability of ICT for educational purposes in schools than the student/computer ratio. The indicator measuring the pupil/computer ratio only provides information on the presence of computers within the school, while this indicator gives a better idea of students' access to the ICT equipment. However, the geographic coverage for this indicator is rather limited, with several of the EU member states not included. Consequently, while the indicator is methodologically interesting, the limited geographical coverage makes it of limited use for the scorecards.
	Eurobarometer	Computers used per 100 pupils	Provides a reasonable proxy of the availability of computers. Moreover, the indicator can be broken down to primary, secondary and professional/technical education, providing a more nuanced picture than the data available from the PISA study. However, in light of the vast qualitative differences in computers, it would be beneficial to have more information on differences in the quality of the computers. Also, the presence of computers does not guarantee their availability for teachers and students.
	Eurobarometer	% of schools with internet connection	Gives a reasonable indication of the existence of Internet in formal education. However, does not provide information on the number or type of internet connections available in the schools.
	Eurobarometer	% of schools with intranet	A useful indicator to proxy the availability of internal networks within the formal education environments. However, the indicator does not specify whether the intranet is used for education purposes.
	Eurobarometer	Percentage of computers in the school which are less than three years old	Poor proxy of the quality of ICT.

Period 1 meso-level (continued)

Variable	Source	Indicator	Comments
Use of ICT by teachers	Eurobarometer	Percentage of teachers using computers with pupils in their education	Good indicator of use, but does not specify the purpose of use sufficiently. Consequently, the manner in which computers are used is left uncovered.
	Eurobarometer	Percentage of teachers using internet with pupils in their education	Coupled with the indicator on use of computers by teachers, the indicator gives an idea of the extent but not how ICT and the Internet are integrated into teaching procedures.
	Eurobarometer	Average number of hours per week ICT is used for teaching purposes	Although the two indicators above provide insight into the extent to which computers and internet is being used by teachers, they do not specify how much time is actually spent with the new learning tools. This indicator provides a good complement to the indicators above, such as to take account of differences in quantity of use.
Availability of digital learning materials			No satisfactory data available.

Table 3 Period 1 micro-level (formal)

Variable	Source	Indicator	Comments
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week	A good indicator of the quantity of use, as it allows for greater variation in the answers by respondents. However, the indicator does not specify purpose of use. The lack of data on purpose and manner of use may increasingly become a problem, as differences in educational practice is an important aspect of the transformation of human investment provision in the formal education environment resulting from the introduction of ICT as a learning tool.
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale of 1 to 5 where 1 is never or hardly ever and 5 is several times a week	A good indicator of the quantity of use, as it allows for greater variation in answers by respondents. However, the indicator does not specify purpose of use. As with the indicator above, the lack of information on purpose and manner of use is a significant limitation.

Table 4 Period 1 micro-level (informal)

Variable	Source	Indicator	Comments
ICT resources in the home	PISA	The number of computers in the home of the student/ Dummy variable of whether there is a computer in the home or not	While the data collected takes account of the differences in quantity of ICT it does not include any differentiation with regard to the quality of ICT resources available within the household. As with the other education environments, data on the availability of ICT should ideally take account of qualitative aspects of ICT equipment, given the rapid speed of technological progress.
		Availability of educational software within the household (dummy variable)	It is not entirely clear what is meant by educational software, leaving plenty of scope for different interpretations of the question. Moreover, the data does not specify the quantity of educational software available within the household. In addition, the geographic coverage of this indicator does not encompass all member states of the EU.
		Average availability of computers in the home on a scale of 1-5 where 1 is almost every day and 5 is never	Provides an indication of the student's own perception of availability. Of interest because the presence of a computer does not guarantee its availability. However, the data is not collected for all member states.
		Average availability of computer in library on a scale of 1-5	Makes it possible to include data on the access to ICT outside the home. However, the data does not include all member states.
		Average availability of computer in other place on a scale of 1-5	An indicator of interest, but the geographic coverage is limited to only a few of the member states.

Period 1 micro-level (informal) (continued)

Variable	Source	Indicator	Comments
Internet availability in the home	PISA	% of pupils with access to a link to the Internet in the home (dummy variable)	Good indicator of the availability of internet in the informal education environment, but the data falls short of specifying qualitative differences in the type of link that is available. The lack of qualitative differentiation will become an increasing problem as technological developments will allow for a wider range of possibilities to access the Internet.
Use of ICT and Internet in the informal education environment	PISA	Use of computer in the home on a scale of 0-4 where 0 is never and 4 is almost every day	Gives a good proxy of the use of ICT in the home, but the geographic coverage is limited and does not include all member states. Furthermore, the data does not specify purpose of use.

5.2 Period 2

Official sources of data have increasingly begun to collect data on adult learning. With the increasing recognition of the role of Lifelong Learning, surveys have been developed to take account of adult participation in education and training activities. Accordingly, significant data on training and education for adults has become available. For example, the OECD now produces data on public expenditure on adult education and training. Of particular interest to this project is the Continuing Vocational Training Surveys (CVTS), which collects data from employers on their provision of training for employees. The survey defines training as an activity where "The primary objective must be the acquisition of new competencies or the development and improvement of existing competencies. Routine work-adjustment (i.e. basic familiarization with the job, organization or working environment) and routine information passing should be excluded" (Eurostat. 2002:8). It should be noted, however, that the survey is entirely focused on identified training time. Hence, the definition of training used in the survey requires that "There must be an actual activity or event or set of activities or events, which can be identified as a specific and separate period of training, rather than an on-going activity that cannot be distinguished from work – such as learning by experience" (Eurostat, 2002:9). The less formalised learning such as opportunities for learning by

doing and participation in communities of practice etc. are not included in the CVTS. Given the emphasis placed on the opportunities for less formalised provision of human investment within organisations in the New Economy, this represents a significant limitation of the data available from the CVTS surveys.

With regard to the new human investment opportunities arising from the introduction and application of ICT for learning purposes, the data collected from the General Population Survey by SIBIS is particularly interesting. The objective of the survey is to cover areas of relevance to the New Economy. The emphasis is thus on new socio-economic variables arising with the introduction of ICT. The subject of the survey is outlined as: "Topics of this survey were statements on interviewees' ownership and use of ICT equipment, use of the Internet and e-commerce activities, competence in the use of new media, questions on health and the Internet, the Internet and security concerns, e-government, telework, mobile work forms, as well as further education and satisfaction with working conditions" (SIBIS, 2003:5). The survey thus covers a range of specific ICT areas, while also aiming to cover some of the socio-economic changes to work, education and citizenship arising from the emergence of the New Economy. Of particular relevance to the operationalisation of human investment are the sections of the survey examining training and lifelong learning by adults, and another section examining working conditions of adults. The General Population Survey takes a rather broad view on training and includes issues such as self-directed learning – an area left uncovered by many of the surveys of adult learning applying a methodology adopted from data collection efforts for period 1. Indeed, a particular problem with many of the efforts to measure adult learning is their failure to satisfactorily account for the differences in the processes of learning between the two periods, arising from children and young people learning in period 1 and adults in period 2.

Hence, it was noted in the preceding chapter that an operationalisation of period 2 need to take account of the individuals and the context of learning specific to this period. In particular, there is a need for indicators capturing the new dimensions to human investment emerging in the workplace. This involves capturing features of the learning organisation as well as activities of the individual employee. While many of the features

of the learning organisation are intangible in nature, and difficult to measure, one approach is to examine how the cultural aspects of the learning organisation manifest themselves in attitudes and perceptions by the individual employee. One such aspect is the extent to which employees feel they participate in a working environment in which they are stimulated to learn, and the extent to which they have sufficient influence amd autonomy to learn from their working experience. The General Population Survey asks questions of adults as to whether they feel their job requires them to continuously learn. Furthermore, the survey collects data on the employees' own perception of autonomy in the workplace. The data from the General Population Survey thus allows for the construction of proxies of participation in learning organizations.

In addition, the stocktaking of data sources expanded its use of data sources beyond data sets traditionally associated with human investment, such as to include data on the workplace and employment characteristics. The third European Working Conditions Survey, 2000 (EWCS) proved very useful in providing data on features of relevance for the operationalisation of the learning organisation. The survey was conducted by the European Foundation, in order to "provide an overview on the state of working conditions throughout Europe, as well as indicating the nature and content of changes affecting the workforce and the quality of work" (European Foundation website, www.eurofound.ie/ewco/surveys/index.htm). Of particular interest, the survey collects data from employees on their views on the workplace, including features that are of relevance for learning opportunities in the non-formal education environment. In particular, there is data on the influence of employees in shaping the organisation in which they work. Also, the data set is rich in information on whether employees think they learn through processes of work.

Furthermore, it is worth noting that with the increasing awareness of the importance of learning and improvement in capacities for competitive advantage, organisations have themselves become increasingly aware of the need to be able to measure their investment in more intangible assets, such as the competences of employees. This is reflected in the increasing importance given to knowledge management within organisations (Kaplan &

Norton, 1996 and Edvinsson and Malone, 1997). Accordingly, several efforts have been made to develop methodologies for measuring the intangible aspects of organisations. Rather than using survey techniques as the method of data collection, the knowledge management literature has attempted to construct indicators on the basis of financial information and administrative data. This highlights different sources of data which has so far been left unexplored in the attempts to construct indicators of human investment. Given the emphasis placed on organisational features among the variables specified for period 2, the indicators constructed in the knowledge management literature may be of interest to this project. The key efforts in this new area were thus taken stock of.

Knowledge management indicators can be separated into financial metrics and non-financial indicators (Malhotra, 2003). The former set of indicators aim to proxy the value of the intangible assets of an organization. The latter set aim to assess the performance of the organisation in a number of areas involving the availability and use of intangible assets. The possible relevance of both categories of indicators is two-fold. Firstly, an aggregation of organizational knowledge management indicators may provide a picture of the extent to which organizations in a country is harnessing and making effective use of intangible assets, including human capital. Secondly, the attempts to construct indicators for the organisation may give insight into areas and sources of data which are relevant for the operationalisation of human investment at a national level. Accordingly, the knowledge management literature may highlight possible methodologies for the development of national human investment indicators. Each of these two possible contributions of the knowledge management literature has been explored. Unfortunately, it became evident that these efforts to measure and manage intangible assets within an organisation do not easily translate into national indicators of human investment. It remains unclear how these efforts at the organisational level can be translated into nationally comparable indicators. This is an area of interest for future research.

In the tables below, the best available indicators for the variables specified for period 2 in the previous chapter have been identified from the data sources that have been taken stock of. Furthermore, the strengths and weaknesses of each of these indicators are

commented upon. It is evident from the tables that the stocktaking of available data and indicators for period 2 of the framework reveal more limitations for a comprehensive operationalisation of human investment. However, while some of the variables within the various cells of table 1 in chapter 4 cannot be satisfactorily measured with the available data, it is possible to measure features at all relevant levels of aggregation and education environments.

Table 5 Period 2 macro-level (formal)

Variable	Source	Indicator	Comments
Public commitment to adult learning	OECD	Expenditure on adult education and training	Narrow but useful measure of commitment to adult education and training. However, the indicator does not take account of the many different ways in which governments can support human investment in period 2, such as tax and subsidies for employers and individuals. Consequently, the indicator does not capture all elements of the public commitment to adult education and training.

Table 6 Period 2 macro-level (non-formal)

Variable	Source	Indicator	Comments
Labour market variables			No satisfactory data available.
Structural rigidities impeding lifelong learning			No satisfactory data available.

Table 7 Period 2 meso-level

Variable	Source	Indicator	Comments
Employer commitment to training	CVTS	Percentage of firms with training programmes for employees	This in itself is a very broad measure of the commitment to human investment which does not take account of the amount of resources devoted to training or the amount of training received by individual employees. For national comparison it may be more desirable to examine the percentage of employees working for employers with training programmes, in order to take account of differences in size of employer organisations.
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	Provides a good proxy of expenditure on training adjusted by the number of employees. However, the indicator does not take account of differences in labour and training costs.
	CVTS	Total cost of CVT courses as a percentage of total labour costs	Coupled with the indicator above, this indicator is a helpful measure of the level of expenditure on training by employers. In particular, it takes account of differences in the overall labour costs for employers.

Period 2 meso-level (continued)

Variable	Source	Indicator	Comments
Learning organisation features	EWCS	% of employees who think they are able to discuss working conditions in general	Provides a useful proxy, but it would be helpful to have more variation in the answer, rather than a categorical variable with only two categories. Also, the opportunity to discuss working conditions is not necessarily tantamount to influence. It would have been of interest to have better information on the nature of the consultation process with employees in the organisation. For example, it is not guaranteed that the discussions feed into the processes of decision making within the organisation. It would be of interest to have better indicators of employee influence in the workplace. Nevertheless, the EWCS currently provides the best data available.
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	Interesting indicator, in particular for the purposes of operationalising learning in organisations facing pressures to change and adapt to new conditions. As with the indicator above, however, it is not guaranteed that such discussions actually lead to influence.
	GPS	Index of employed who feel they have a lot of say over what happens in job	Coupled with the indicators from the EWCS, this indicator sheds light on the extent to which employees have the autonomy and influence in shaping the workplace required to facilitate learning. However, lack of sufficient variation in the answers represents a weakness of the indicators on perceived autonomy. Also, it could be argued that an employee may not feel in control of their work because of continued change and introduction of new work processes and technology. A lack of control may therefore not reflect a lack of autonomy, but rather a perpetually changing work environment.
ICT/Network resources in the workplace	GDMS	% of firms with intranet	Provides a proxy of the extent to which communication within the organisation is facilitated. However, the quality of the data is rather poor, and it is debatable whether information about the existence of the technology for internal communication is sufficient as an indicator of the extent to which such communication is actually taking place. Moreover, the geographic coverage of the data is limited, with only some of the 15 member states included.

Table 8 Period 2 micro-level (non-formal)

Variable	Source	Indicator	Comments
Participation in training	CVTS	Average number of CVT course hours per employee	Provides a useful proxy of the training provided to employees. Is better than available indicators on the percentage of employees participating in CVT courses because it provides a measure of the quantity of training received.
	GPS	% of employed taking part in work-related training by third party in last 4 weeks	Provides an important addition to the data from the CVTS in as so far as the respondent is the individual employee rather than the employer. However, the data does not specify whether the training is financed by the employer or employee.
	GPS	Percentage of individuals participating in work-related self-directed learning in last 4 weeks	The question asked is limited to self-directed learning related to work, allowing for the development of an indicator of self-directed learning for the non-formal education environment. However, there is no information as to the location or financing of the self-directed learning efforts. It is thus unclear to what extent these efforts are supported by employers.
Learning on-the-job/ participation in communities of practice	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	Gives a good proxy of the extent to which participation in daily activities at work, and working with others in the workplace, contributes to learning. May also be useful as a proxy of the existence of communities of practice.
	EWCS	Percentage of employed who think their main job involves learning new things	Gives an interesting insight into the nature of the work, and whether the day-to-day activities in the workplace are conducive for learning.
	EWCS	Percentage of employed who think their skills match the demands imposed by the job	While it is a proxy of the extent to which skills are being utilised, and thus maintained, in the workplace, it is a rather crude indicator. It would be beneficial to have better data on the maintenance and depreciation of skills in the workplace.
	GPS	Percentage of individuals who feel their job requires them to continuously learn	The sample from this survey is less representative than the data from EWCS, and does therefore not provide as good an indicator.
ICT and Internet use in the workplace	GPS	Index of average time used on the internet at work	This provides an interesting indication of the extent to which the use of Internet has been integrated into work practices in organisations. However, it does not specify whether the time spent on the Internet is for learning purposes. It would be useful to have more information on the nature of use, and the quality of the ICT resources available to employees.

Table 9 Period 2 micro-level (informal)

Variable	Source	Indicator	Comments
ICT availability in the home	OECD	Percentage of households with PC	Useful indicator of availability of computers in the informal education environment. However, the data does not take account of qualitative differences between computers. Given the rapid progress in the development of computer technology indicators of ICT resources should ideally take account of the qualitative differences in ICT equipment. The lack of data on quality and quantity of computers in the household thus represents a significant weakness for the indicators that can be constructed.
	ECHP	Percentage of household with a computer	It does not specify the quantity nor quality of the computers available. Does not add to the information provided in the OECD data.
Internet access in the home	OECD	Percentage of households with internet access	Useful indicator of availability of internet in the informal education environment. However, as with the data on the availability of computers, the data does not take account of qualitative differences between types of internet access.
	GPS	Percentage of households with internet access	While this data is better than the available OECD data, in as so far as it tries to differentiate between types of access, the sample is poorer and less representative.
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	Does not specify place of use, which is a major weakness, but it is the best proxy available.
	GPS	Average time spent on the internet at home in a typical week	Good indicator of the extent to which the available internet access is actually used. The data allows for the construction of an index of use where none equals 0 and 5 is 20 hours or more. In addition to the data on the time spent on the Internet, the survey also collects data on the different purposes to which the Internet can be used. Accordingly, the survey asks interviewees whether they have undertaken a number of activities on the Internet, and whether they have undertaken any of these in the last four weeks prior to the interview. However, none of these activities are directly related to human investment, and are therefore of little relevance to the operationalisation of the use of the Internet for human investment purposes.

Table 10 Period 2 micro-level (formal)

Variable	Source	Indicator	Comments
Adult participation in formal education	OECD	Students aged 20-29 as % of population aged 20-29	Useful indicators to measure enrolment rates for the adult population. Does not specify whether it is full- or part-time students, which is a rather big weakness. Moreover, the data for the 40+ group is not available for all countries.
	OECD	Students aged 30-39 as % of the population aged 30-39	
	OECD	Students aged 40+ as % of the population aged 40+	
Participation in distance learning provided by formal educational institutions			No satisfactory data available.

5.3 Conclusion

Extensive data has been collected for period 1. Several sources are available for the operationalisation of the availability and use of ICT in the formal and informal education environments. However, all data sources seem to assume that the availability and use of ICT takes account of all the new dimensions to education during period 1. As noted in chapter 4, an important issue is the way in which pedagogy and teaching methods are transformed to make full use of the learning potential provided by the new technologies. For example, is the new technology used for a continuation of rote learning, or is it ushering in more flexible teaching methods that can accommodate the requirements of each individual student? This is an important aspect of the transformation of human investment provision, and cannot be satisfactorily operationalised with the available data.

Furthermore, the data collected on ICT in formal and informal education environments of period 1 tends to focus exclusively on the availability of hardware, without exploring the potentially significant role of software. In particular, the difference between ICT being used as glamorous typewriters and the technology used effectively as an educational tool is likely to be dependent on the available educational software. The lack of satisfactory data on the quantity and quality of educational software available to the student in school and at home represent one of the principal weaknesses of existing data sources. While it is difficult to develop indicators that can satisfactorily capture the quantity and quality of software, the significance of software for the effective utilisation of ICT should make this an area of high priority.

The methodological approach adopted for the collection of data for adult learning seems predominantly to have been based on the methodology used for operationalising formal education. The emphasis in much of the data collected for period 2 has therefore been on the participation of adults in formalised training courses rather than the extent to which learning has been integrated into working processes of organizations. Unfortunately, this has created data on human investment which measure the extent to which the non-formal and informal education environments of period 2 provide features resembling the formal education environment, rather than the particular context and situations of learning facing people in period 2. This is particularly problematic given the emphasis on the work-context in much of the recent literature on adult learning. However, by extending the stocktaking of data to sources not traditionally associated with the measurement of human investment, it has been possible to identify possible indicators for the non-formal and informal education environments of period 2.

In light of the data limitations discussed in this chapter, the operationalisation of the conceptual framework developed in chapter 3 is thus working under a number of constraints. Nevertheless, some data is available for all dimensions of the framework, and in the next chapter the efforts of chapters 4 and 5 will be brought together in the development of scorecards of human investment for each of the 15 member states of the EU.

Chapter 6

Measuring human investment

6.1 Introduction

In the preceding chapters a conceptual framework has been developed, variables specified, and possible data sources reviewed and assessed. The conceptual framework and subsequent specification of variables concluded that human investment was becoming transformed as a result of the emergence of the New Economy. Individuals are increasingly required to learn throughout their lives, but are also increasingly able to learn in a number of education environments. However, for learning to properly take place in the different educational environments, it was argued that changes were required at the level of the individual, household, organisation and country. The successful transformation of human investment provision is dependent on action being taken by the individual learner, but also the organisations which can provide a potential education environment, notably the formal education institution and the workplace, and the allocation of time and resources towards this transformation by the country as a whole.

However, does this transformation of human investment require the number of indicators reviewed in chapter 5? In other words, does using the multitude of indicators discussed in the previous chapter reveal anything different about a country's performance than merely using more traditional indicators of human investment, such as those measuring investment and participation at the macro-level of period 1? If the use of a vast number of new indicators reveal little different from traditionally used measures of human investment, the value of using these additional indicators is very limited. Accordingly, an operationalisation of human investment in the era of the New Economy needs to consider the extent to which the transformations of human investment require policy makers to look at a number of new indicators when benchmarking performance for the purposes of the OMC. In order to explore this issue further, it is necessary to examine whether the picture emerging from using the multitude of indicators reviewed in chapter 5 reveal a different picture of human investment provision in the European Union, compared to that revealed by the more

traditional indicators of human investment associated with the macro-level of period 1. It is the purpose of this chapter to structure the data in a manner that allows for an easy comparison of the performance of each member state in the different dimensions of the human investment framework developed in chapter 3 and 4. Accordingly, in this chapter a set of indicators will be constructed for each member state, based on the reviewed data sources in chapter 5, which appropriately resonate with the conceptual framework and variables outlined in chapters 3 and 4.

Accordingly, the primary objective of this chapter is to construct scorecards of indicators reflecting the different dimensions of human investment outlined in the preceding chapters. In addition, based on the indicators of the scorecards, the measurement of human investment will be presented in radar-diagrams of composite indicators displaying the relative performance of countries in the different educational environments. The methodological approach to constructing the composite indicators is outlined later in this chapter.

6.2 Scorecards

The reasons for using a scorecard approach are two-fold. Firstly, the scorecard allows us to capture the multi-dimensionality of human investment outlined in the conceptual framework. Secondly, the emphasis placed on the efforts at different levels of aggregation requires a wider set of indicators. The scorecard is well suited to tackle these problems. By organising the used indicators in a scorecard structured in accordance with the conceptual framework outlined in the preceding chapters, it is possible to measure the performance of a country in all the relevant dimensions of human investment provision. Whilst providing an overall picture of human investment provision, the scorecard also gives more detailed measurements of all the transformations of human investment, restricting simplistic policy conclusions.

The scorecards for each period have been developed on the basis of the various educational environments relevant for each period. Each relevant educational environment will therefore be represented at the micro-level with its own part in the scorecard. In addition, the scorecard for each period will have a part for the organisational changes at the meso-level and another part for the overall commitment

to human investment at the macro-level. As with the specification of variables in chapter 5, the meso-level for period 1 is limited to the organisational variables for the formal education environment, while the meso-level for period 2 is limited to organisational variables for the non-formal education environment. The formal education environment of period 1 and non-formal education environment of period 2 contain the most significant organisations in the paradigm of lifelong learning, and thus merit specific attention within the scorecard.

The scorecards are presented in Annex 1 and 2 of this chapter. Both scorecards have five columns each. The first column shows the variables to be measured, as they were specified in chapter 4. The second column gives the source of the data as taken stock of in chapter 5. Column three shows the indicator used to measure the variable specified in column 1 with the data from the source shown in column 2. The fourth column gives the value of the indicator. In order to facilitate comparison, each of the indicators is also presented as an index score calculated with the EU average as 100. This index score is displayed in the column furthest to the right of each scorecard, and allows for easier comparison of the 15 EU member states with regard to all dimensions of human investment.

6.2.1 Period 1

The box for the macro-level of period 1 consists of indicators measuring the overall commitment to period 1 human investment as measured by the time and resources devoted to formal education for individuals prior to them entering the labour force. These are what would be considered 'traditional' human investment indicators. Accordingly, the indicators used to capture the overall commitment to human investment in period 1 are the levels of expenditure (both public and private) on formal education as a percentage of GDP and enrolment rates for different age groups. To take adequately account of the differences in wage structures and thus costs of human resources for human investment between countries, a separate indicator for the teacher resources in formal education is also included in this segment of the scorecard for period 1.

The box for the meso-level contains indicators reflecting the take-up and use of new education technologies within the formal education organisations. These indicators

are intended to show the organisational transformation of formal education providers as they adapt to the new technological innovations associated with the New Economy. In accordance with the specification of variables in chapter 4, this segment of the scorecard contains indicators measuring the human investment in teachers, availability of ICT resources in formal education, and the use of ICT by teachers in formal education. For each indicator there are measurements for the formal education environment as a whole. In addition, since the transformation of formal education is likely to be different at different levels of education, all the indicators are further separated into measurements for primary, secondary and professional and technical education. However, for the latter the sample is not representative for all countries.

The micro-level of period 1 consists of a box each for the formal and informal education environments. The indicators for these boxes are intended to measure the new means of learning available to individual learners in the formal and informal education environments. As in chapter 4, the non-formal education environment is not included, as its limited importance does not merit further analysis. The segment for the formal education environment contains indicators of pupils' use of the new education technologies becoming available with the emergence of the New Economy. Similarly, the part for the informal education environment contains indicators of the availability and use of new learning technologies in the home. Overall, the scorecard for period 1 thus contains indicators of the transformations that are taking place to human investment provision in the relevant education environments and at different levels of aggregation. The scorecards for all 15 member states are presented in Annex 1 of this chapter.

6.2.2 Period 2

The scorecard for period 2 is similarly structured as that for period 1. A box of indicators for the macro-level measures the overall commitment to adult education and training. The indicators in the box for the meso-level capture the commitment to training by employers and the existence of organisational structures conducive to learning. However, it is important to note that the organisational change in period 2 differs from that for period 1. In period 2 the individual learner in question is the employee, whereas in period 1 the individual learner is a user of the organisation, i.e. the student. This has implications for what aspects of the organisation in which we

have an interest in relation to human investment. Hence, the variables and indicators of the meso-level for period 1 and 2 are clearly different. The micro-level is separated into the non-formal, informal and formal education environments, and measures learning activities of the individual learner within each of these. Again, the scorecard contains indicators capturing the transformations to human investment taking place in the different education environments and at various levels of aggregation. The scorecards for all 15 member states are presented in Annex 2 of this chapter.

6.3 Composite indicators

The scorecards provide a comprehensive view of human investment provision in the EU member states. However, the vast number of indicators in the two scorecards do not allow for easy comparison of human investment in the different countries. Accordingly, the objective of the remainder of this chapter is to construct composite indicators for each of the boxes in the scorecards. These composite indicators will be presented in radar diagrams, which will allow for easier analysis of the relative strengths and weaknesses of each member state. In particular, it will allow for an easier analysis of the relative performance in the different education environments and at different levels of aggregation. There will be a radar diagram for each period for each country. The diagram will display the values of the composite indicators, whilst also showing the performance of each country relative to the best performing country in the EU. The blue area of the difference between the best-performing indicators and the indicators of the country thus displays the country's overall gap in human investment provision for the period between itself and the best performance. These radar diagrams are presented in Annex 3 of this chapter.

A significant methodological problem when constructing composite indicators is the determination of the relative significance of each sub-indicator within the composite. The appropriate relative weight of each component of the composite indicator is always a contested issue. For the purposes of this project the weights will be attached as is deemed most suitable for taking account of the issues raised in the conceptual framework and subsequent specification of variables. However, in order to test how sensitive each composite indicator is to the weightings of the sub-indicators, a comprehensive sensitivity analysis is conducted. In what follows, the weights for the

composite indicators will be specified, and the composite indicators constructed and presented. Subsequently, the sensitivity analysis will be outlined and conducted.

6.3.1 Period 1

Macro-level: There are four sub-indicators of different types of resources devoted to formal education. A precondition for anyone participating in and gaining from formal education is sufficient financial resources being devoted to it. Accordingly, the component measuring the total public and private expenditure on education as a percentage of GDP is given a weight of 0.4. However, in order to take account of differences in labour markets and how these differences may affect the extent to which human resources are devoted to formal education, a sub-indicator of the teacher/pupil ratio is included with a weight of 0.1. To capture the time devoted to formal education through participation, the two enrolment indicators are included with a weight of 0.25 each. The combined weights attached to financial and human resources on the one hand, and the human investment taking place through participation on the other, is thus 0.5 each.

Meso-level: While the scorecards provide indicators for each level of education, only the indicators for the education system as a whole will be used in the construction of the composite indicator. At the meso-level there are three variables measured. Each of these refer to different aspects of the changes taking place at the level of the organisation as a result of the introduction of new education technologies. All three variables are of great importance and closely interrelated, and the poor performance in one is likely to render the others of less significance for the overall human investment provision in the formal education environment of period 1. Consequently, all three variables should have a fairly even distribution of weights. The indicators of ICT resources in formal education measure the extent to which new technologies are made available in schools and are given a combined weight of 0.4 (0.2 to the number of computers per 100 pupils and 0.1 each to the availability of internet and intranet). The other two variables refer to changes in teaching practices and whether training to facilitate these changes is provided. Each of these variables is given a weighting of 0.3. For both variables, the weighting is split equally between the indicators.

Micro-level (formal): The variables refer to the use of computers and internet by pupils respectively. Both variables are of potentially great importance for the human investment provision in the formal education environment. The indicators used to measure the two variables are given an equal weight of 0.5.

Micro-level (informal): The composite indicator at this level is made up of four sub-indicators. The data for the last indicator in the scorecard only covers few of the countries, and is therefore not included in the composite indicator. The two indicators measuring the availability of computers in the household are given a combined weight of 0.4 (0.3 to the indicator measuring the % of pupils with at least one computer at home and 0.1 to the average number of computers in the home of students, because the marginal benefit of extra computers in the home may be rapidly diminishing, with additional computers only adding little to the facilitation of human investment provision in the informal education environment). Similarly, the indicator measuring the access to the internet in the home is given a 0.4 weighting. The indicator measuring the availability of educational software is given the remaining weight of 0.2. The access to computers and the internet are arguable very important conditions for being able to make proper use of the new human investment opportunities arising as part of the New Economy. Not only does the availability of computers largely precondition the use of educational software, but the availability of computers and internet are requirements for the participation in learning networks becoming increasingly available through the application of new technologies to human investment provision. The two variables measuring access to computers and the internet are therefore given more weight than the availability of educational software.

6.3.2 Period 2

Meso-level: There are two broad categories of indicators at the meso-level of period 2. One category of indicators measures the commitment to and expenditure of employers on training courses for their employees. The other category of indicators measures the extent to which organisations facilitate processes of learning, i.e. are learning organisations. Each of these broad categories of indicators is an important aspect of the organisational changes required to facilitate human investment in the non-formal education environment of period 2. Accordingly, each broad category of indicators is assigned a total weight of 0.5. Among the sub-indicators measuring the

commitment to and expenditure of employers on training for employees, the training enterprises as a percentage of all enterprises is given a weight of 0.2, while the remaining two indicators measuring expenditure levels are given a weight of 0.15 each. Since the latter two indicators are different measures of the same variable, yet this variable of the expenditure levels on training is a critical element of training provided by employers, it is deemed reasonable to give this variable a total weight of 0.3. For the indicators measuring the extent to which the non-formal education environment facilitates learning, the sub-indicators measuring the percentage of employed who feel they can discuss working conditions and conditions of change are given weights of 0.2 each, while the index of employed who feel they have a lot of say over what happens in their job is given a weight of 0.1. The reason for allocating the weights in this manner is partly that the first two indicators measure aspects of the non-formal education environment which are directly related to the involvement of employees in shaping the conditions of the organisation in which they work, partly that the data for the latter indicator is of a lesser quality than the former two. Furthermore, the data for the indicator measuring the percentage of firms with intranet is only available for a few countries, and is therefore not included in the composite indicator.

Micro-level (non-formal): As with the meso-level, there are two broad categories of indicators at the micro-level of the non-formal education environment. One category of indicators refers to the participation of employees in work-related training. The other category of indicators measures the extent to which employees learn through the activities in the workplace. As with the indicators at the meso-level, each of these broad categories is given a combined weight of 0.5. Among the three sub-indicators measuring work-related training, the weights are distributed accordingly: 0.2 to the average number of hours of training per employee, 0.15 to the percentage of employed taking part in self-directed work-related training, and 0.15 to the percentage of employed taking part in work-related training by third party. The reason for allocating the weights in this manner is that the first indicator measures the intensity of training provided totally or in part by employers, while the latter two indicators are measures of the rate of participation. For the category of indicators measuring learning through activities in the workplace, there are three indicators included in the composite. The first two indicators are more direct measures of learning in the

workplace, while the latter is a measure of the skill-match of employees. From a human investment perspective, the first two are therefore of greater importance than the third indicator. Consequently, the weights are distributed in the following way: 0.2 each to the indicators measuring the percentage of employed who feel they can get assistance from their colleagues and the percentage of employed who thinks their main job involves learning new things. 0.1 is given to the third indicator measuring the skill-match of employees.

Micro-level (informal): The four sub-indicators for this composite are all measures of either the access to or use of ICT in the home. Accordingly, each of the sub-indicators is given equal weight. The data for the three indicators from the GPS measuring participation in training for future job and the use of electronic learning materials is of such a poor quality that these indicators are not included in the composite.

Micro-level (formal): Only the two indicators measuring enrolment of population aged 20-29 and 30-39 are included in the composite indicators. The third indicator measuring enrolment of population aged 40+ is unavailable for several countries, and the inclusion of this measure in the composite indicator is likely to distort the comparability of the composite indicator too much. Furthermore, the measure of enrolment for the population aged 20-29 is given a weight of 0.6 while the measure of enrolment for the population aged 30-39 is given the remaining weight of 0.4. This is because the value of formal education is deemed greater the lower the age of the person participating.

6.4 Sensitivity analysis

As noted above, the assignment of weights to sub-indicators in a composite indicator is always a contested exercise. Not only are the weights assigned to composite indicators at any given point in time always debatable but the relative importance of sub-indicators may change over time. Indeed, as technologies are developed and organisational structures changed, the relative importance of the sub-indicators will change as well. Consequently, it is of interest to know how sensitive the results obtained in the section above are to changes in the weights attached to the sub-indicators. In order to test the sensitivity, this project will conduct a simulation

exercise that will give us an idea of the confidence we can have in the results obtained.

For each composite indicator, 10000 combinations of random weights are created. For each country, the 10000 combinations of random weights are attached to the sub-indicators. We thus have 10000 different values of each composite indicator for each country. For each country, the analysis of the distribution of the 10000 values of each composite indicator will constitute the sensitivity analysis. More specifically, the mean and standard deviation of each distribution of values for each country and composite indicator will allow us to estimate a confidence interval of {(mean - 2 * standard deviation) : (mean + 2 * standard deviation)}. The wider the interval, the greater the sensitivity of the composite indicator to the weights attached.

Furthermore, a second part of the sensitivity analysis will ascertain the sensitivity of the composite indicators to changes in the weight given to each of the sub-indicators. As with the first part of the sensitivity analysis, this second part is a simulation exercise. For each sub-indicator of each composite indicator of each country, 1000 random weights are attached to the sub-indicator in question while the weights of all other sub indicators in the composite are held constant at 0.5. For each sub-indicator in the composite we thus have a distribution of 1000 composite values. The standard deviations for each of the distributions are then calculated. In total we have a standard-deviation for each sub-indicator for each country. Wide variation in the standard deviations will then be indicative of greater sensitivity, with sub-indicators with very different standard deviation from the others explaining the overall sensitivity of the composite indicator. What is of particular interest is whether different countries display relatively greater sensitivity to the weighting attached to different sub-indicators within each composite.

6.4.1 Outcomes of first part of sensitivity analysis

The outcomes of the sensitivity analysis are presented graphically in Annex 4 of this chapter. Of course, the countries with most variation in the values of the sub-indicators will display the greatest sensitivity to the weightings attached. For both periods, some composite indicators for some countries thus display far wider intervals

than others. Accordingly, the values of the composite indicators with wide intervals should be interpreted with greater caution. Furthermore, the position in the distribution of the composite indicators presented above will allow for an examination of whether the value, but also rank, of a country is particularly sensitive to the weights attached to the sub-indicators. However, it is worth noting that the values of all composite indicators presented above fortunately lie within the confidence intervals. In the following the sensitivity of each composite indicator will be briefly outlined.

6.4.1.1 Period 1

Macro-level

Belgium, Denmark, Germany and Italy have particularly wide confidence intervals. Furthermore, and more worrying, the positioning of countries in their respective distribution are very different. This is particularly a problem for Germany, Ireland, Greece and Italy, where the distributions overlap. Germany and Ireland are ranked higher than Greece and Italy, but the two former countries are placed at the top end of their distribution while the latter two are at the bottom end of their confidence intervals. Similarly the distributions of Belgium, Denmark and Sweden overlap, with both Sweden and Denmark having higher composite value than Belgium. However, the value of the composite indicator for Belgium is at the bottom end of the distribution while the Swedish composite indicator is at the top end.

Meso-level

Denmark and Luxembourg have wide confidence intervals and thus display greater sensitivity to the weightings given to the sub-indicators. However, while almost the entire confidence interval for the Danish composite indicator is placed above the distributions of all other member states, the distribution of Luxembourg overlaps with the distributions of most other member states. The rank of Luxembourg is therefore particularly sensitive to the weights attached to the sub-indicators.

Micro-level (formal)

Denmark, Finland, Italy and Sweden have wide confidence intervals, but the value of the composite indicator is positioned very close to the mean of the distributions for all member states. However, a closer look at the scorecards reveals that the relative performance of countries on the two sub-indicators is very different. Some countries

scoring high on the first sub-indicator will perform worse on the other while other countries will display the opposite pattern. The value of the composite indicator and rank of countries is therefore sensitive to how the weights are distributed between the sub-indicators.

Micro-level (informal)

Only Sweden and Denmark have fairly wide confidence intervals. However, most of the confidence interval for Sweden is above the confidence intervals of other member states, while the relative position of Denmark against the Netherlands and UK is more sensitive to the weightings of sub-indicators. Furthermore, while Austria, Belgium, Germany and Finland show rather narrow confidence intervals, the latter is placed at the top end of its confidence interval while the former three are all placed at the bottom of theirs. Since the distributions of all four countries overlap, the relative positions of the countries are greatly affected by the way weightings are attached to the sub-indicators.

6.4.1.2 Period 2

Meso-level

Denmark, Greece and the UK have the widest confidence intervals. However, while most of the confidence interval for Denmark is above the intervals of the other member states, the wide distributions of Greece and the UK displays the sensitivity in their ranking to the weightings of the sub-indicators. Furthermore, while the value of the composite indicator is close to the mean of the distribution for most countries, the scorecard reveals differences in the relative performance of countries in different sub-indicators. However, overall this appears to be one of the more robust composite indicators with respect to the ranking of countries.

Micro-level (non-formal)

Austria, France and Germany have the widest confidence intervals. A particular problem for this composite indicator is that the distribution of values of the composite indicator among the member states is very narrow. Consequently, even small confidence intervals can make the ranks of countries very sensitive to the weightings of the sub-indicators.

Micro-level (informal)

Denmark, Greece and Sweden have the widest confidence intervals. While the confidence intervals for Denmark and Sweden are both almost entirely above the distributions of all other member states, the wide confidence interval of Greece overlaps with all 12 of the other member states. The close positioning of the 13 member states (except Denmark and Sweden) makes the ranks of all these countries highly sensitive to weightings. Indeed, examination of the scorecards shows that countries are relatively stronger in different sub-indicators, increasing the sensitivity of the composite indicator.

Micro-level (formal)

This is possibly the least robust of the composite indicators. Sweden and the UK have extremely wide confidence intervals, while Greece displays a wide distribution and several other countries have fairly wide confidence intervals. Fortunately, the confidence intervals of both Sweden and the UK are above the intervals of most of the other member states, but a lot of care is needed in the interpretation and analysis of the composite indicator.

6.4.2 Outcomes of second part of sensitivity analysis

The outcome of the second part of the sensitivity analysis is displayed in Annex 5 of this chapter. In the following, the findings for each composite indicator will be outlined. Subsequently, the implications of both parts of the sensitivity analysis will be discussed.

6.4.2.1 Period 1

Macro-level

Four countries (Belgium, Denmark, Germany and Italy) display differences in standard deviations for their sub-indicators greater than 10. These are also the countries which display greatest sensitivity overall in the first part of the sensitivity analysis. However, while Belgium, Denmark and Italy show greatest sensitivity to changes in the weight given to the fourth sub-indicator, Germany shows greatest sensitivity to the weight given to the third sub-indicator and very little sensitivity to the weight given to the fourth sub-indicator. For the other countries, the overall

sensitivity is less of a problem, and the sensitivity is fairly evenly distributed across all four sub-indicators.

Meso-level

The first part of the analysis showed that it was Luxembourg and Denmark that had greatest sensitivity to the weightings attached to the sub-indicators. The second part of the analysis shows that it is the third sub-indicator (computers used per 100 pupils) which makes these two countries particularly sensitive. Both countries show notably high standard deviations for this indicator. A closer examination of the scorecards reveals that it is the particularly strong performance of both Denmark and Luxembourg on this indicator that generates the sensitivity.

Micro-level (formal)

The first part of the sensitivity analysis showed that Denmark and Italy showed greatest sensitivity, while most of the other countries had more narrow confidence intervals. The results from part two of the sensitivity analysis show that the very impressive performance on the second sub-indicator causes more sensitivity for Denmark, while for Italy it is the relatively better performance in the first sub-indicator and rather poor performance in the second sub-indicator which causes the sensitivity.

Micro-level (informal)

Part one of the sensitivity analysis showed that Sweden displayed greatest sensitivity to the weightings attached to sub-indicators. The second part of the analysis reveals that it is the fourth sub-indicator (% of pupils with internet access at home) which generates the greatest sensitivity. It is the very impressive performance of Sweden on this indicator that gives rise to the sensitivity.

6.4.2.2 Period 2

Meso-level

Denmark, Greece and the UK showed greatest sensitivity in the first part of the analysis. However, the second part reveals that it is different sub-indicators which cause the sensitivity in the three countries. For Denmark, it is the impressive performance on the second sub-indicator (Total cost of CVT courses per employee)

which causes the sensitivity. In contrast, it is the generally poor performance on all but the last sub-indicator (index of employed who feel they have a lot of say over what happens in job) which causes the sensitivity of the composite indicator for Greece. The last sub-indicator is above the EU average while all the others are well below the EU average. In the case of the UK, it is the performance well above the EU average on the third sub-indicator (Total cost of CVT courses as a % of total labour costs) which is the main contributor to the sensitivity of the composite indicator.

Micro-level (non-formal)

This proved to be one of the more robust composite indicators in the first part of the sensitivity analysis. However, four countries, Austria, Denmark, France and Germany, showed a wider confidence interval than the other countries. The second part of the sensitivity analysis reveals that it is the relatively strong performance on the first sub-indicator which causes the sensitivity for Denmark and France, while it is the impressive performance on the second sub-indicator which gives rise to the sensitivity for Austria and Germany. It is worth noting that the sensitivity of France is less to do with a comparatively strong performance on the first (and to some extent the fifth) sub-indicator and more to do with the comparatively poor performance on the remaining sub-indicators.

Micro-level (informal)

Denmark, Greece, Portugal and Sweden were shown to have wide confidence intervals in the first part of the analysis. The second part of the analysis reveals that it is the particularly strong performance on the second sub-indicator (% of households with internet access) which causes the sensitivity. For Greece and Portugal it is the poor performance on all but the fourth sub-indicator which causes the sensitivity. The latter (index of the use of internet in the home by people with access) is above the EU average while the others are well below the EU average. However, it is worth noting that the fourth sub-indicator has to be viewed in light of the poor performance of both Greece and Portugal on the second sub-indicator (% of households with internet access). As the percentage of households with internet increases, the average use of

the internet by those with access may well decline as it is those with greatest use gaining access first[1].

Micro-level (formal)

The first part of the sensitivity analysis showed that the composite indicators for notably Sweden and the UK, but also Greece, were very sensitive to the weightings attached to the sub-indicators. For both Sweden and the UK it is the very impressive performance on the second sub-indicator (Students aged 30-39 as % of the population aged 30-39) which causes the sensitivity. The sensitivity of Greece, on the other hand, is due to its very poor performance on the second sub-indicator coupled with an average performance on the first.

The analysis above makes it clear that some of the composite indicators display a degree of sensitivity with regard to weighting, that makes it necessary to interpret the results with care. More specifically, it is important to establish the methodological implications of the sensitivity for any subsequent analysis. Arguably, the great sensitivity shown in the analysis above brings into question the usefulness of the composite indicators as means of benchmarking. However, rather than dismissing the results, it may be worth considering why some of the countries display such sensitivity for some of the composite indicators. Sensitivity may be due to particular political attention given to some components of the composite indicator, and little priority given to others. Indeed, the second part of the sensitivity analysis showed that it was different sub-indicators giving rise to the sensitivity for different countries. The composite indicator may therefore overlook specific political priorities within a country. This suggests that a satisfactory construction of composite indicators should include more information on the relative importance given to each sub-indicator within each country. Increasingly, problems of this sort have been dealt with through the application of the Delphi method making use of expert groups aiming to establish a consensus on the relative importance and weighting of the sub-indicators (Adler and Ziglio, 1996). An application of such a methodology could be of great interest for future research on the operationalisation of human investment. In particular, as

[1] This is in accordance with DeLong's Law stating that the most valuable nodes to a network will be connected first, diminishing the potential for increasing returns to the widening of networks as predicted by Metcalfe's Law.

educational technologies are further developed, and their application is partly shaped by and partly sets in motion further organisational and pedagogical change, it is likely to become of increasing importance to ask questions of the relative importance given to indicators measuring these transformations to human investment provision. Satisfactory answers to such questions will inevitably require wider consultation with major decision-makers and stakeholders than the scope of this project allows for. These issues will be further discussed in subsequent chapters.

6.5 Conclusion

The purpose of this chapter has been to create sets of indicators measuring human investment that resonate with the conceptual framework developed in the preceding chapters and make use of the data sources taken stock of in chapter 5. However, whilst measuring the new dimensions to human investment provision in the era of the New Economy, the measurements presented in this chapter still leave us with gaps unfilled for a fully satisfactory operationalisation of human investment. Most importantly, neither the scorecards nor the composite indicators presented in the radar-diagrams tell us of the relative importance of the different dimensions in each country in shaping human investment outcomes. Indeed, the outcome of the sensitivity analysis conducted in this chapter suggests that there may be significant differences between countries in the priorities given to different sub-indicators.

Moreover, it was noted in chapter 4, that a number of more systemic and institutional features in both periods may determine the use and role of new learning technologies. For example, the nature of pupils' use of the new educational technologies in the informal education environment of period 1 may be shaped by parent characteristics and other domestic features. Similarly, wider institutional processes of the education system may affect and shape schools' and pupils' adoption of new learning opportunities arising out of the technological innovations associated with the New Economy. The importance of the new learning opportunities arising from the new education technologies may therefore differ significantly across countries. Consequently, in the next chapter, the measurements of human investment presented in this chapter will be coupled with a set of indicators measuring the systemic variables specified in chapter 4 capturing the relative significance of the new aspects of human investment provision. This exercise will be limited to period 1, due to lack

of data for period 2. The combination of the indicator scorecards, radar diagrams and the indicators of systemic variables will provide a comprehensive picture of human investment provision in the EU. This picture will be further examined in the subsequent chapters, with particular emphasis on how the picture emerging from the conceptual and operational approach developed in this project differs from that arrived at from traditional comparative measures of human investment provision. This will be followed by an outline of the implications from the analysis conducted in this project.

Annex 1

Country: Austria
Period 1

Variable	Source	Indicator	Value	Index**
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	5.1	112
	OECD	Public expenditure as % of GDP	4.9	115
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	98.7	106
		Students aged 15-19 as % of the population of 15-19-year-olds	76.9	101
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.1059322	116
		Primary	0.09398496	129
		Secondary	0.11641444	116
		Profess. & Technic.	0.09587728	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified***	0.949261	111
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	64	119
		Primary	56	103
		Secondary	74	137
		Profess. & Technic.	66	
		Internet in their teaching	43	115
		Primary	34	93
		Secondary	53	138
		Profess. & Technic.	59	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	11	107
		Primary	9.3	115
		Secondary	11.7	82
		Profess. & Technic.	17.2	
	Eurobarometer	% of schools with internet connection	72	89
		Primary	53	70
		Secondary	95	108
		Profess. & Technic.	96	
	Eurobarometer	% of schools with intranet connection	45	108
		Primary	24	79
		Secondary	69	122
		Profess. & Technic.	69	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	69	105
		Primary	59	91
		Secondary	83	133
		Profess. & Technic.	69	
	Eurobarometer	% of teachers using Internet with pupils in their education	42	99
		Primary	23	65
		Secondary	66	141
		Profess. & Technic.	45	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	1.6	43
		Primary	1.3	42
		Secondary	1.5	49
		Profess. & Technic.	1.2	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.701094	128
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.252586	142
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.258983	119
	PISA	% of pupils with at least one computer at home	88	122
	PISA	% of pupils with educational software in the household	60.3	106
Internet availability in the home	PISA	% of pupils with Internet access at home	38.88	95
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	-	

* Profess. & Technic. Sample is not representative for most of the countries
** Index where 100 = EU non-weighted average
*** Quality of data and indicator not satisfactory for being included in composite indicator

Country: Belgium
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.9	107
	OECD	Public expenditure as % of GDP	4.6	108
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	100.2	108
		Students aged 15-19 as % of the population of 15-19-year-olds	91	119
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.131926	145
		Primary	0.080908	111
		Secondary	0.145773	145
		Profess. & Technic.	0.202429	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.8965	104
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	51	95
		Primary	46	85
		Secondary	58	107
		Profess. & Technic.	63	
		Internet in their teaching	34	91
		Primary	25	68
		Secondary	49	128
		Profess. & Technic.	48	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	10.2	99
		Primary	9	111
		Secondary	12.4	86
		Profess. & Technic.	32.3	
	Eurobarometer	% of schools with internet connection	91	112
		Primary	90	120
		Secondary	96	109
		Profess. & Technic.	94	
	Eurobarometer	% of schools with intranet connection	50	120
		Primary	42	138
		Secondary	73	129
		Profess. & Technic.	67	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	81	124
		Primary	86	132
		Secondary	70	112
		Profess. & Technic.	68	
	Eurobarometer	% of teachers using Internet with pupils in their education	43	101
		Primary	34	96
		Secondary	51	109
		Profess. & Technic.	55	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	4.9	133
		Primary	3.3	107
		Secondary	4.3	140
		Profess. & Technic.	1.5	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.005681	104
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.967817	86
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.230856	116
	PISA	% of pupils with at least one computer at home	82.9	115
	PISA	% of pupils with educational software in the household	69.4	122
Internet availability in the home	PISA	% of pupils with Internet access at home	41.77	102
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.655818	

* Profess. & Technic. Sample is not representative for most of the countries

Country: Denmark
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	5.8	127
	OECD	Public expenditure as % of GDP	5.6	131
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	97.2	104
		Students aged 15-19 as % of the population of 15-19-year-olds	82.9	109
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.13812155	151
		Primary	0.11086475	153
		Secondary	0.18382353	183
		Profess. & Technic.	0.10964912	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.992835	116
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	68	126
		Primary	69	127
		Secondary	67	124
		Profess. & Technic.	58	
		Internet in their teaching	59	158
		Primary	58	158
		Secondary	58	151
		Profess. & Technic.	52	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	30.6	298
		Primary	23.5	290
		Secondary	66.9	466
		Profess. & Technic.	42.4	
	Eurobarometer	% of schools with internet connection	98	121
		Primary	98	130
		Secondary	99	112
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	66	158
		Primary	63	207
		Secondary	67	119
		Profess. & Technic.	80	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	95	145
		Primary	88	136
		Secondary	86	138
		Profess. & Technic.	100	
	Eurobarometer	% of teachers using Internet with pupils in their education	83	196
		Primary	69	194
		Secondary	79	169
		Profess. & Technic.	94	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	5.1	138
		Primary	2.8	91
		Secondary	3.8	124
		Profess. & Technic.	3.4	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	4.141373	144
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	4.069338	178
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.56576	148
	PISA	% of pupils with at least one computer at home	91.2	126
	PISA	% of pupils with educational software in the household	59.5	105
Internet availability in the home	PISA	% of pupils with Internet access at home	65.31	159
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.926261	

* Profess. & Technic. Sample is not representative for most of the countries

Country: Finland
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	5.2	114
	OECD	Public expenditure as % of GDP	5.2	122
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	93.5	101
		Students aged 15-19 as % of the population of 15-19-year-olds	85.3	112
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.0895255	98
		Primary	0.0609013	84
		Secondary	0.0956838	95
		Profess. & Technic.	0.0994036	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.940146	109
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	76	141
		Primary	77	142
		Secondary	81	150
		Profess. & Technic.	66	
		Internet in their teaching	56	150
		Primary	57	155
		Secondary	58	151
		Profess. & Technic.	48	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	16.6	161
		Primary	13.4	165
		Secondary	14.8	103
		Profess. & Technic.	30.1	
	Eurobarometer	% of schools with internet connection	99	122
		Primary	99	132
		Secondary	99	112
		Profess. & Technic.	97	
	Eurobarometer	% of schools with intranet connection	28	67
		Primary	13	43
		Secondary	26	46
		Profess. & Technic.	74	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	94	144
		Primary	95	146
		Secondary	83	133
		Profess. & Technic.	88	
	Eurobarometer	% of teachers using Internet with pupils in their education	78	184
		Primary	78	220
		Secondary	75	161
		Profess. & Technic.	70	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	4.5	122
		Primary	3.7	120
		Secondary	2.9	94
		Profess. & Technic.	1.6	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.609818	125
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.505527	153
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.140559	108
	PISA	% of pupils with at least one computer at home	81.7	113
	PISA	% of pupils with educational software in the household	52.2	92
Internet availability in the home	PISA	% of pupils with Internet access at home	54.87	134
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.725954	

* Profess. & Technic. Sample is not representative for most of the countries

Country: France
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	5.4	118
	OECD	Public expenditure as % of GDP	5	117
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	101	109
		Students aged 15-19 as % of the population of 15-19-year-olds	86.6	114
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.0880282	96
		Primary	0.0496032	68
		Secondary	0.0902527	90
		Profess. & Technic.	0.1070664	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.888134	103
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	44	82
		Primary	39	72
		Secondary	46	85
		Profess. & Technic.	45	
		Internet in their teaching	29	78
		Primary	27	74
		Secondary	29	76
		Profess. & Technic.	28	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	9.5	92
		Primary	6.4	79
		Secondary	10.5	73
		Profess. & Technic.	37.8	
	Eurobarometer	% of schools with internet connection	84	104
		Primary	63	84
		Secondary	97	110
		Profess. & Technic.	98	
	Eurobarometer	% of schools with intranet connection	38	91
		Primary	13	43
		Secondary	55	97
		Profess. & Technic.	57	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	61	93
		Primary	76	117
		Secondary	52	83
		Profess. & Technic.	57	
	Eurobarometer	% of teachers using Internet with pupils in their education	32	75
		Primary	27	76
		Secondary	34	73
		Profess. & Technic.	39	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	2.9	79
		Primary	2.6	84
		Secondary	2	65
		Profess. & Technic.	0.8	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.357166	82
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.807594	79
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.821577	78
	PISA	% of pupils with at least one computer at home	65.8	91
	PISA	% of pupils with educational software in the household	51.3	90
Internet availability in the home	PISA	% of pupils with Internet access at home	26.78	65
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Germany
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.6	101
	OECD	Public expenditure as % of GDP	3.9	92
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	100.1	108
		Students aged 15-19 as % of the population of 15-19-year-olds	89.4	117
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.0487805	53
		Primary	0.0626174	86
		Secondary	0.0661813	66
		Profess. & Technic.	0.0036058	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.969828	113
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	35	65
		Primary	38	70
		Secondary	35	65
		Profess. & Technic.	26	
		Internet in their teaching	22	59
		Primary	21	57
		Secondary	23	60
		Profess. & Technic.	21	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	4.9	48
		Primary	4.3	53
		Secondary	7.1	49
		Profess. & Technic.	3.5	
	Eurobarometer	% of schools with internet connection	94	116
		Primary	90	120
		Secondary	98	111
		Profess. & Technic.	97	
	Eurobarometer	% of schools with intranet connection	40	96
		Primary	26	86
		Secondary	52	92
		Profess. & Technic.	66	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	53	81
		Primary	37	57
		Secondary	53	85
		Profess. & Technic.	74	
	Eurobarometer	% of teachers using Internet with pupils in their education	36	85
		Primary	11	31
		Secondary	38	81
		Profess. & Technic.	51	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	2.7	73
		Primary	1.1	36
		Secondary	2.5	81
		Profess. & Technic.	1.1	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.481237	86
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.791174	78
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.337366	126
	PISA	% of pupils with at least one computer at home	87	121
	PISA	% of pupils with educational software in the household	65	115
Internet availability in the home	PISA	% of pupils with Internet access at home	39.31	96
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.791137	

* Profess. & Technic. Sample is not representative for most of the countries

Country: Greece
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	3.9	85
	OECD	Public expenditure as % of GDP	3.6	85
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	98.1	105
		Students aged 15-19 as % of the population of 15-19-year-olds	77	101
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.106157	116
		Primary	0.079239	109
		Secondary	0.108342	108
		Profess. & Technic.	0.2	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.844959	98
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	40	74
		Primary	35	64
		Secondary	43	80
		Profess. & Technic.	47	
		Internet in their teaching	24	64
		Primary	17	46
		Secondary	29	76
		Profess. & Technic.	24	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	4.9	48
		Primary	1.5	18
		Secondary	6	42
		Profess. & Technic.	18.3	
	Eurobarometer	% of schools with internet connection	45	56
		Primary	22	29
		Secondary	58	66
		Profess. & Technic.	85	
	Eurobarometer	% of schools with intranet connection	18	43
		Primary	6	20
		Secondary	26	46
		Profess. & Technic.	32	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	22	34
		Primary	12	18
		Secondary	26	42
		Profess. & Technic.	45	
	Eurobarometer	% of teachers using Internet with pupils in their education	11	26
		Primary	4	11
		Secondary	14	30
		Profess. & Technic.	32	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	2.8	76
		Primary	0.5	16
		Secondary	2.8	91
		Profess. & Technic.	1.6	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.736147	95
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.011168	88
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.534581	51
	PISA	% of pupils with at least one computer at home	44.7	62
	PISA	% of pupils with educational software in the household	35.5	63
Internet availability in the home	PISA	% of pupils with Internet access at home	24.2	59
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Ireland
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.5	99
	OECD	Public expenditure as % of GDP	4.1	96
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	100.6	108
		Students aged 15-19 as % of the population of 15-19-year-olds	80.9	106
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.069493	76
		Primary	0.055586	76
		Secondary	0.074405	74
		Profess. & Technic.	0.068213	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.983506	114
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	74	137
		Primary	82	151
		Secondary	70	130
		Profess. & Technic.	78	
		Internet in their teaching	49	131
		Primary	57	155
		Secondary	45	117
		Profess. & Technic.	59	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	10.9	106
		Primary	8.6	106
		Secondary	12.1	84
		Profess. & Technic.	79.9	
	Eurobarometer	% of schools with internet connection	98	121
		Primary	96	128
		Secondary	99	112
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	42	101
		Primary	16	53
		Secondary	69	122
		Profess. & Technic.	73	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	83	127
		Primary	95	146
		Secondary	71	114
		Profess. & Technic.	70	
	Eurobarometer	% of teachers using Internet with pupils in their education	71	167
		Primary	80	225
		Secondary	60	129
		Profess. & Technic.	61	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	6.2	168
		Primary	6.5	211
		Secondary	4.2	137
		Profess. & Technic.	1.4	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.745937	95
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.699022	74
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.818357	77
	PISA	% of pupils with at least one computer at home	67.4	93
	PISA	% of pupils with educational software in the household	69.4	122
Internet availability in the home	PISA	% of pupils with Internet access at home	42.67	104
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.222655	

* Profess. & Technic. Sample is not representative for most of the countries

Country: Italy
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.2	92
	OECD	Public expenditure as % of GDP	3.9	92
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	99.4	107
		Students aged 15-19 as % of the population of 15-19-year-olds	72.2	95
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.124069	136
		Primary	0.124844	172
		Secondary	0.113379	113
		Profess. & Technic.	0.153374	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.829957	97
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	58	108
		Primary	61	112
		Secondary	53	98
		Profess. & Technic.	41	
		Internet in their teaching	33	88
		Primary	35	95
		Secondary	29	76
		Profess. & Technic.	25	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	5.5	54
		Primary	4.5	55
		Secondary	11.1	77
		Profess. & Technic.	12.5	
	Eurobarometer	% of schools with internet connection	89	110
		Primary	87	116
		Secondary	98	111
		Profess. & Technic.	97	
	Eurobarometer	% of schools with intranet connection	60	144
		Primary	58	191
		Secondary	69	122
		Profess. & Technic.	74	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	69	105
		Primary	65	100
		Secondary	82	131
		Profess. & Technic.	82	
	Eurobarometer	% of teachers using Internet with pupils in their education	33	78
		Primary	26	73
		Secondary	58	124
		Profess. & Technic.	63	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	2.6	70
		Primary	2	65
		Secondary	4.5	146
		Profess. & Technic.	1.4	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.245319	113
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.592781	70
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.859759	81
	PISA	% of pupils with at least one computer at home	69.7	97
	PISA	% of pupils with educational software in the household	47.6	84
Internet availability in the home	PISA	% of pupils with Internet access at home	32.53	79
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Luxembourg
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	-	
	OECD	Public expenditure as % of GDP	-	
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	92.2	99
		Students aged 15-19 as % of the population of 15-19-year-olds	78.1	103
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.110132	121
		Primary	0.089286	123
		Secondary	0.117786	117
		Profess. & Technic.	0.06502	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.852452	99
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	41	76
		Primary	43	79
		Secondary	34	63
		Profess. & Technic.	60	
		Internet in their teaching	21	56
		Primary	21	57
		Secondary	20	52
		Profess. & Technic.	34	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	32.2	313
		Primary	45.8	565
		Secondary	16	111
		Profess. & Technic.	8.9	
	Eurobarometer	% of schools with internet connection	92	114
		Primary	86	114
		Secondary	100	113
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	49	118
		Primary	14	46
		Secondary	95	168
		Profess. & Technic.	67	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	36	55
		Primary	27	42
		Secondary	41	66
		Profess. & Technic.	53	
	Eurobarometer	% of teachers using Internet with pupils in their education	36	85
		Primary	27	76
		Secondary	41	88
		Profess. & Technic.	53	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	2.5	68
		Primary	4.1	133
		Secondary	6.4	208
		Profess. & Technic.	1.1	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.140742	109
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.800813	122
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.291739	122
	PISA	% of pupils with at least one computer at home	82.9	115
	PISA	% of pupils with educational software in the household	65.7	116
Internet availability in the home	PISA	% of pupils with Internet access at home	49.22	120
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.91807	

* Profess. & Technic. Sample is not representative for most of the countries

Country: Netherlands
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.3	94
	OECD	Public expenditure as % of GDP	4	94
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	99.3	107
		Students aged 15-19 as % of the population of 15-19-year-olds	86.2	113
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.08658	95
		Primary	0.074129	102
		Secondary	0.092081	92
		Profess. & Technic.	0.118765	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.965998	112
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	62	115
		Primary	63	116
		Secondary	59	109
		Profess. & Technic.	67	
		Internet in their teaching	35	94
		Primary	36	98
		Secondary	34	89
		Profess. & Technic.	28	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	12.5	122
		Primary	11.9	147
		Secondary	11	77
		Profess. & Technic.	30.3	
	Eurobarometer	% of schools with internet connection	93	115
		Primary	91	121
		Secondary	100	113
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	44	106
		Primary	35	115
		Secondary	75	133
		Profess. & Technic.	89	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	90	137
		Primary	96	148
		Secondary	73	117
		Profess. & Technic.	89	
	Eurobarometer	% of teachers using Internet with pupils in their education	38	90
		Primary	34	96
		Secondary	43	92
		Profess. & Technic.	72	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	6.6	179
		Primary	7.3	237
		Secondary	3.9	127
		Profess. & Technic.	1.2	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.542068	88
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.460786	108
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.648104	156
	PISA	% of pupils with at least one computer at home	95.4	132
	PISA	% of pupils with educational software in the household	84.5	149
Internet availability in the home	PISA	% of pupils with Internet access at home	61.11	149
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Portugal
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	5.2	114
	OECD	Public expenditure as % of GDP	5.1	120
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	107	115
		Students aged 15-19 as % of the population of 15-19-year-olds	73.3	98
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.105932	116
		Primary	0.091575	126
		Secondary	0.116414	116
		Profess. & Technic.	0.146199	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.759518	88
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	37	69
		Primary	38	70
		Secondary	36	67
		Profess. & Technic.	11	
		Internet in their teaching	21	58
		Primary	20	55
		Secondary	24	63
		Profess. & Technic.	11	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	4	39
		Primary	3.8	47
		Secondary	5.7	40
		Profess. & Technic.	15.4	
	Eurobarometer	% of schools with internet connection	62	77
		Primary	56	74
		Secondary	91	103
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	25	60
		Primary	15	49
		Secondary	67	119
		Profess. & Technic.	58	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	40	61
		Primary	39	60
		Secondary	41	66
		Profess. & Technic.	56	
	Eurobarometer	% of teachers using Internet with pupils in their education	21	50
		Primary	18	51
		Secondary	24	51
		Profess. & Technic.	56	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	1.1	30
		Primary	1.1	36
		Secondary	0.9	29
		Profess. & Technic.	1.2	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.678549	93
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.289058	100
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.720513	68
	PISA	% of pupils with at least one computer at home	56.9	79
	PISA	% of pupils with educational software in the household	44.2	78
Internet availability in the home	PISA	% of pupils with Internet access at home	23.96	58
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Spain
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.5	99
	OECD	Public expenditure as % of GDP	4	94
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	103.6	111
		Students aged 15-19 as % of the population of 15-19-year-olds	80.1	105
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.087489	96
		Primary	0.064309	88
		Secondary	0.098717	98
		Profess. & Technic.	0.106045	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.998883	116
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	63	117
		Primary	67	123
		Secondary	59	109
		Profess. & Technic.	56	
		Internet in their teaching	47	126
		Primary	48	131
		Secondary	46	120
		Profess. & Technic.	49	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	7.2	70
		Primary	6.9	85
		Secondary	7.4	52
		Profess. & Technic.	27	
	Eurobarometer	% of schools with internet connection	94	116
		Primary	91	121
		Secondary	95	108
		Profess. & Technic.	98	
	Eurobarometer	% of schools with intranet connection	35	84
		Primary	27	89
		Secondary	39	69
		Profess. & Technic.	53	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	44	67
		Primary	46	71
		Secondary	39	62
		Profess. & Technic.	62	
	Eurobarometer	% of teachers using Internet with pupils in their education	22	52
		Primary	19	53
		Secondary	23	49
		Profess. & Technic.	41	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	1.6	43
		Primary	1.4	45
		Secondary	1.3	42
		Profess. & Technic.	1.2	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.656384	92
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	1.703953	74
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	0.825577	78
	PISA	% of pupils with at least one computer at home	67.4	93
	PISA	% of pupils with educational software in the household	54.4	96
Internet availability in the home	PISA	% of pupils with Internet access at home	23.81	58
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)		

* Profess. & Technic. Sample is not representative for most of the countries

Country: Sweden
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	6.1	134
	OECD	Public expenditure as % of GDP	5.9	138
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	98.1	105
		Students aged 15-19 as % of the population of 15-19-year-olds	86.4	113
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.094697	104
		Primary	0.096805	133
		Secondary	0.094518	94
		Profess. & Technic.	0.069396	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.957097	111
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	63	117
		Primary	66	121
		Secondary	61	113
		Profess. & Technic.	59	
		Internet in their teaching	52	139
		Primary	54	147
		Secondary	51	133
		Profess. & Technic.	47	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	15.3	149
		Primary	10.1	124
		Secondary	23.1	161
		Profess. & Technic.	22.3	
	Eurobarometer	% of schools with internet connection	100	124
		Primary	100	133
		Secondary	100	113
		Profess. & Technic.	100	
	Eurobarometer	% of schools with intranet connection	71	170
		Primary	67	220
		Secondary	78	138
		Profess. & Technic.	100	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	81	124
		Primary	80	123
		Secondary	79	126
		Profess. & Technic.	71	
	Eurobarometer	% of teachers using Internet with pupils in their education	66	156
		Primary	54	152
		Secondary	68	146
		Profess. & Technic.	41	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	5.3	144
		Primary	4.7	153
		Secondary	4.6	150
		Profess. & Technic.	0.7	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.602722	125
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.568762	156
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.571026	149
	PISA	% of pupils with at least one computer at home	94.5	131
	PISA	% of pupils with educational software in the household	76.7	135
Internet availability in the home	PISA	% of pupils with Internet access at home	82.49	201
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	3.27335	

* Profess. & Technic. Sample is not representative for most of the countries

Country: UK
Period 1

Variable	Source	Indicator	Value	Index
Macro				
Public commitment to formal education	OECD	Public and private expenditure as % of GDP	4.8	105
	OECD	Public expenditure as % of GDP	4.1	96
Participation in formal education	OECD	Students aged 5-14 as % of the population of 5-14-year-olds	98.7	106
		Students aged 15-19 as % of the population of 15-19-year-olds	74.7	98
Teacher resources				
- quantity	Eurobarometer	Teacher/pupil ratio	0.091912	101
		Primary	0.044803	62
		Secondary	0.113507	113
		Profess. & Technic.	-	
- quality	PISA	% of full-time teachers with ISCED5A in pedag or fully certified	0.909272	106
Meso				
Human investment in teachers	Eurobarometer	% of teachers who have received official training for the use of computers in their teaching	74	137
		Primary	79	145
		Secondary	68	126
		Profess. & Technic.	-	
		Internet in their teaching	56	150
		Primary	61	166
		Secondary	48	125
		Profess. & Technic.	-	
ICT resources in formal education	Eurobarometer	Computers used per 100 pupils	11.1	108
		Primary	8.5	105
		Secondary	15.5	108
		Profess. & Technic.	-	
	Eurobarometer	% of schools with internet connection	95	117
		Primary	93	124
		Secondary	98	111
		Profess. & Technic.	-	
	Eurobarometer	% of schools with intranet connection	63	151
		Primary	51	168
		Secondary	83	147
		Profess. & Technic.	-	
Use of ICT by teachers	Eurobarometer	% of teachers using computers with pupils in their education	100	153
		Primary	100	154
		Secondary	100	160
		Profess. & Technic.	-	
	Eurobarometer	% of teachers using Internet with pupils in their education	60	142
		Primary	56	158
		Secondary	67	144
		Profess. & Technic.	-	
	Eurobarometer	Average number of hours per week per teacher ICT is used for teaching purposes	7.5	203
		Primary	7.9	256
		Secondary	6.9	225
		Profess. & Technic.	-	
Micro (formal)				
Use of ICT by students	PISA	Frequency of use of computers by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	3.709148	129
Use of Internet by students	PISA	Frequency of use of Internet by pupils on a scale from 1 to 5 where 1 is never or hardly ever and 5 is several times a week (index)	2.609139	114
Micro (informal)				
ICT resources in the home	PISA	Average number of computers in home of students (index)	1.527355	144
	PISA	% of pupils with at least one computer at home	90.2	125
	PISA	% of pupils with educational software in the household	81	143
Internet availability in the home	PISA	% of pupils with Internet access at home	57.72	141
Use of ICT and Internet in the home	PISA	Pupil use of computer in the home on a scale of 0-4 where 0 never and 4 is almost every day (index)	2.565129	

* Profess. & Technic. Sample is not representative for most of the countries

Annex 2

Variable	Country: Austria Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.18	59
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	72	109
Employer expenditure on training	CVTS	Total cost of CVT courses per employee****	365	80
	CVTS	Total cost of CVT courses as a % of total labour costs	1.3	63
Learning organisation variables	EWCS	% of employees who think they are able to discuss working conditions in general	89.8	92
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	68.1	94
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.211	104
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	9	69
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	47.9	152
		% of employed taing part in work-related training by third party in last 4 weeks	28.9	109
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace(*****)	107.33	104
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	81.4	59
	EWCS	% of employed who thinks their main job involves learning new things	69.7	98
		% of employed who think their skills match the demands imposed by job	82.6	99
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	34	84
	OECD	% of households with internet access	19	83
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	63	112
		Use of internet in the home by people with access (index)**	1.955	94
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	40	
		Participation in training for future job*****	15.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	39.4	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	18.8	80
		Students aged 30-39 as % of the population aged 30-39	4.1	83
		Students aged 40+ as % of the population aged 40+	0.4	

* Index where 100 = EU non-weighted average

** index calculated as average score from answer to hours per week on internet at home, where none=0, less than 1=1, 1-5=2, 6-10=3, 11-20=4, 20+=5 (N.B. some of the samples for the calculation of this index are too small)

*** index calculated as average score from answer to days of training provided or paid for by employer over the last 12 months, where 0=no training, 1=<5 days, 2=5-9 days, 3=10-19 days, 4=20-49 days, 5=50-100+ days

**** (PPS), due to the omission of indirect labour cost in the total labour cost data, the UK training costs figures are not comparable with other countries

***** sample insufficient to provide valid and reliable data (indicators will therefore not be included in composite indicator)

Variable	Country: Belgium Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.25	82
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	70	106
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	675	111
	CVTS	Total cost of CVT courses as a % of total labour costs	1.6	77
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	79.1	105
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	76.6	106
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.099	95
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	13	99
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	24.1	77
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	23	87
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	113.12	109
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	82.7	100
	EWCS	% of employed who thinks theirmainjob involves learning new things	74.2	104
	EWCS	% of employed who think their skills match the demands imposed by job	85.6	103
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	45.4	113
	OECD	% of households with internet access	13.5	59
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	54.9	97
		Use of internet in the home by people with access (index)**	2.252	109
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	11.5	
		Participation in training for future job*****	17.9	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	41.3	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	26.5	114
		Students aged 30-39 as % of the population aged 30-39	7.3	147
		Students aged 40+ as % of the population aged 40+	2.9	

Variable	Country: Denmark Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.85	280
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	96	146
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	1132	187
	CVTS	Total cost of CVT courses as a % of total labour costs	3	145
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	88.4	117
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	84	116
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.493	129
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	22	168
Work-relsted training	GPS	% of employed taking part in work-relsted self-directed learning in last 4 weeks	32.6	104
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	31.8	120
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	133.56	129
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	92.4	112
	EWCS	% of employed who thinks theirmainjob involves learning new things	84.2	118
	EWCS	% of employed who think their skills match the demands imposed by job	91.1	109
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	65	161
	OECD	% of households with internet access	48	201
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	72.5	128
		Use of internet in the home by people with access (index)**	1.992	96
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	17.9	
		Participation in training for future job*****	13.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	43.1	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	31.5	135
		Students aged 30-39 as % of the population aged 30-39	5.7	115
		Students aged 40+ as % of the population aged 40+	0.9	

Variable	Country: Finland Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.3	99
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	82	125
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	698	115
	CVTS	Total cost of CVT courses as a % of total labour costs	2.4	116
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	86.2	114
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	85.1	117
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.205	104
	GDMS	Percentage of firms with intranet	59.2	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	18	137
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	48.1	153
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	41.6	157
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	119.95	116
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	86.2	105
	EWCS	% of employed who thinks theirmainjob involves learning new things	89.5	125
	EWCS	% of employed who think their skills match the demands imposed by job	91.3	110
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	47	117
	OECD	% of households with internet access	30	131
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	61	108
		Use of internet in the home by people with access (index)**	1.722	83
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	26.7	
		Participation in training for future job*****	21.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	35.1	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	39.2	169
		Students aged 30-39 as % of the population aged 30-39	10.4	210
		Students aged 40+ as % of the population aged 40+	2.1	

Variable	Country: France Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.25	82
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	76	116
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	753	124
	CVTS	Total cost of CVT courses as a % of total labour costs	2.4	116
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	72.2	96
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	72.3	100
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.092	94
	GDMS	Percentage of firms with intranet	50.9	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	17	129
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	13	41
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	20.9	79
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	80.11	77
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	77.9	95
	EWCS	% of employed who thinks theirmainjob involves learning new things	73.8	103
	EWCS	% of employed who think their skills match the demands imposed by job	80.9	97
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	27.7	69
	OECD	% of households with internet access	11.9	52
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	45	80
		Use of internet in the home by people with access (index)**	2.113	102
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	26.7	
		Participation in training for future job*****	21.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	31.6	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	19.6	84
		Students aged 30-39 as % of the population aged 30-39	1.7	34
		Students aged 40+ as % of the population aged 40+	-	

Variable	Country: Germany Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP*	0.34	112
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	75	114
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	508	83
	CVTS	Total cost of CVT courses as a % of total labour costs	1.5	73
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	71.1	94
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	69.5	96
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.21	104
	GDMS	Percentage of firms with intranet	51.2	205
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	9	69
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	54.3	173
		% of employed taing part in work-related training by third party in last 4 weeks	28	105
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	101.2	98
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	85.4	104
	EWCS	% of employed who thinks theirmainjob involves learning new things	67.8	95
	EWCS	% of employed who think their skills match the demands imposed by job	84.7	102
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	47.3	117
	OECD	% of households with internet access	16.4	72
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	64.4	114
		Use of internet in the home by people with access (index)**	2.057	99
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	12.5	
		Participation in training for future job*****	7.7	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	39.7	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	24.2	104
		Students aged 30-39 as % of the population aged 30-39	2.8	57
		Students aged 40+ as % of the population aged 40+	0.2	

* only unemployed

Variable	Country: Greece Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	-	
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	18	27
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	223	37
		Total cost of CVT courses as a % of total labour costs	0.9	44
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	67.7	90
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	64.8	89
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.287	111
	GDMS	Percentage of firms with intranet	43.9	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	6	46
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	11.6	37
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	18.3	69
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	114	110
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	63.5	77
	EWCS	% of employed who thinks theirmainjob involves learning new things	44.9	63
	EWCS	% of employed who think their skills match the demands imposed by job	82.3	99
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	-	
	OECD	% of households with internet access	-	
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	29.5	52
		Use of internet in the home by people with access (index)**	2.387	114
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	27	
		Participation in training for future job*****	14.3	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	38.7	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	23.8	102
		Students aged 30-39 as % of the population aged 30-39	0.3	6
		Students aged 40+ as % of the population aged 40+	-	

Variable	Country: Ireland Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	-	
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	79	120
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	600	99
	CVTS	Total cost of CVT courses as a % of total labour costs	2.4	116
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	79.3	105
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	73.8	102
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.026	88
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	17	129
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	24	76
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	23.7	89
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	94.13	91
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	87.2	106
	EWCS	% of employed who thinks theirmainjob involves learning new things	68	95
	EWCS	% of employed who think their skills match the demands imposed by job	81.1	97
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	32.4	80
	OECD	% of households with internet access	20.4	89
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	63	112
		Use of internet in the home by people with access (index)**	1.768	85
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	3	
		Participation in training for future job*****	8.3	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	52	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	16.6	71
		Students aged 30-39 as % of the population aged 30-39	3	61
		Students aged 40+ as % of the population aged 40+	-	

Variable	Country: Italy Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	-	
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	24	36
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	563	93
	CVTS	Total cost of CVT courses as a % of total labour costs	1.7	82
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	68.7	91
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	68.9	95
	GPS	Index of employed who feel they have a lot of say over what happens in job	0.963	83
	GDMS	Percentage of firms with intranet	58.2	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	8	61
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	30.1	96
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	23.5	88
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	105.29	102
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	76.3	93
	EWCS	% of employed who thinks theirmainjob involves learning new things	70	98
	EWCS	% of employed who think their skills match the demands imposed by job	78.6	94
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	29.4	73
	OECD	% of households with internet access	18.8	82
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	42.5	75
		Use of internet in the home by people with access (index)**	1.882	91
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	38.9	
		Participation in training for future job*****	5.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	48.6	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	17.1	74
		Students aged 30-39 as % of the population aged 30-39	2	40
		Students aged 40+ as % of the population aged 40+	-	

Variable	Country: Luxembourg Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	-	
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	71	108
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	592	98
	CVTS	Total cost of CVT courses as a % of total labour costs	1.9	92
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	81.2	108
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	77.6	107
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.16	100
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	14	107
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	46	146
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	21.9	82
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	94.48	91
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	84.2	102
	EWCS	% of employed who thinks theirmainjob involves learning new things	72.4	101
	EWCS	% of employed who think their skills match the demands imposed by job	74.9	90
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	-	
	OECD	% of households with internet access	-	
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	62	110
		Use of internet in the home by people with access (index)**	2.01	97
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	18.6	
		Participation in training for future job*****	11.5	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	36.4	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	6	26
		Students aged 30-39 as % of the population aged 30-39	0.3	6
		Students aged 40+ as % of the population aged 40+	-	

Variable	Country: Netherlands Period 2 Source	Indicator	Value	Index value[a]
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.45	148
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	88	134
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	875	144
	CVTS	Total cost of CVT courses as a % of total labour costs	2.8	135
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	90.1	119
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	87.1	120
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.26	109
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	15	114
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	29.9	95
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	27.1	102
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	91.5	88
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	90	109
	EWCS	% of employed who thinks theirmainjob involves learning new things	79.7	112
	EWCS	% of employed who think their skills match the demands imposed by job	83.9	101
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	-	
	OECD	% of households with internet access	-	
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	73.4	130
		Use of internet in the home by people with access (index)**	2.04	98
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	26.7	
		Participation in training for future job*****	21.1	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	43.3	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	24.3	104
		Students aged 30-39 as % of the population aged 30-39	3.2	65
		Students aged 40+ as % of the population aged 40+	0.7	

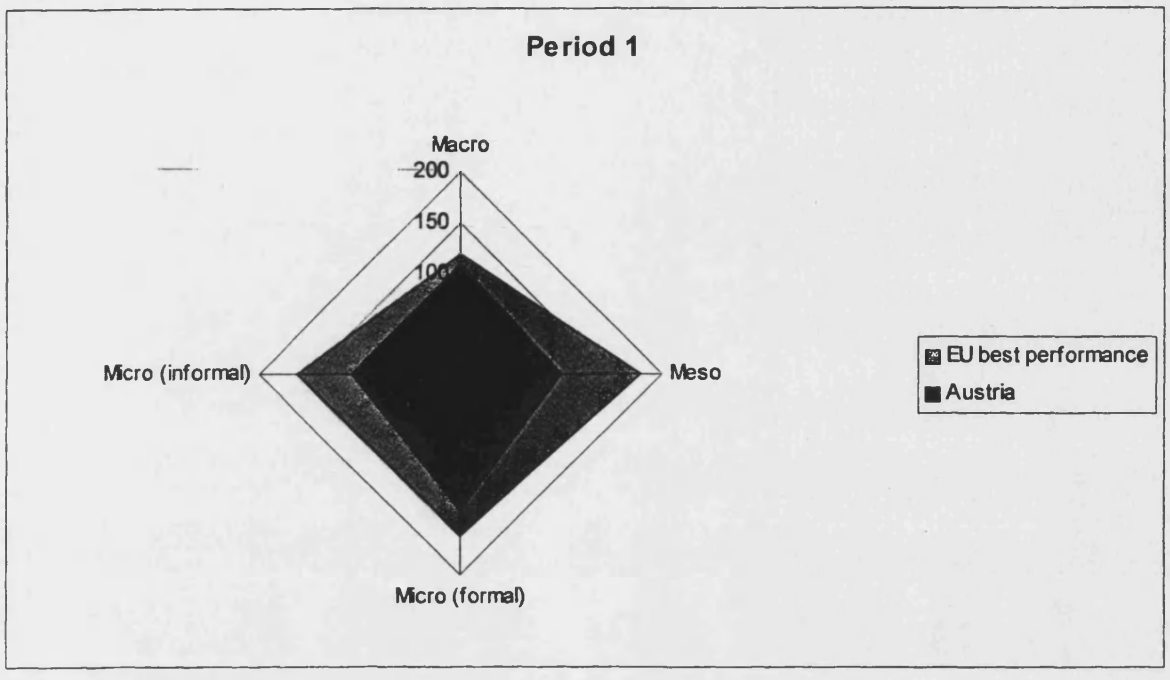
Variable	Country: Portugal Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.16	53
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	22	33
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	240	40
	CVTS	Total cost of CVT courses as a % of total labour costs	1.2	58
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	46.8	62
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	45.7	63
	GPS	Index of employed who feel they have a lot of say over what happens in job	0.925	80
	GDMS	Percentage of firms with intranet		
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	7	53
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	21.3	68
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	14.4	54
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	72.27	70
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	70.2	85
	EWCS	% of employed who thinks theirmainjob involves learning new things	57	80
	EWCS	% of employed who think their skills match the demands imposed by job	87.6	105
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	27	67
	OECD	% of households with internet access	8	35
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	31.6	56
		Use of internet in the home by people with access (index)**	2.301	111
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	25	
		Participation in training for future job*****	7.4	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	44.4	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	21.7	93
		Students aged 30-39 as % of the population aged 30-39	3.4	69
		Students aged 40+ as % of the population aged 40+	0.6	

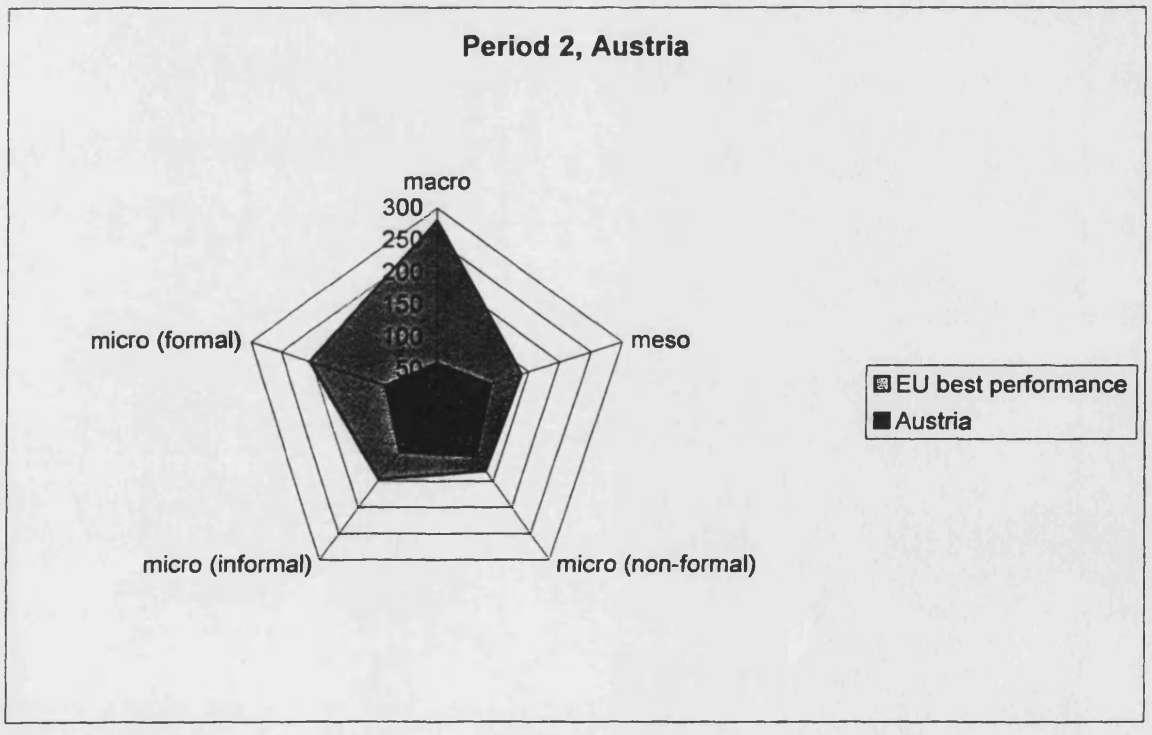
Variable	Country: Spain Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.21	69
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	36	55
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	385	63
	CVTS	Total cost of CVT courses as a % of total labour costs	1.5	73
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	67.9	90
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	61.9	85
	GPS	Index of employed who feel they have a lot of say over what happens in job	1.118	96
	GDMS	Percentage of firms with intranet	56.2	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	11	84
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	24	76
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	29.7	112
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	86.13	83
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	76.7	93
	EWCS	% of employed who thinks theirmainjob involves learning new things	64.4	90
	EWCS	% of employed who think their skills match the demands imposed by job	81.9	98
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	30.4	75
	OECD	% of households with internet access	-	
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	46.3	82
		Use of internet in the home by people with access (index)**	2.284	110
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	11.5	
		Participation in training for future job*****	8.5	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	49	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	23.5	101
		Students aged 30-39 as % of the population aged 30-39	2.5	50
		Students aged 40+ as % of the population aged 40+	0.4	

Variable	Country: UK Period 2 Source	Indicator	Value	Index value*
Macro				
Public commitment to adult learning	OECD	Public expenditure on training for adult employed and unemployed as % of GDP	0.05	16
Meso				
Employer commitment to training	CVTS	Training enterprises as a % of all enterprises	87	132
Employer expenditure on training	CVTS	Total cost of CVT courses per employee	628	103
	CVTS	Total cost of CVT courses as a % of total labour costs	3.6	174
Learning organsiation variables	EWCS	% of employees who think they are able to discuss working conditions in general	79.6	106
	EWCS	% of employees who think they are able to discuss organisation of their work when changes take place	74.9	103
	GPS	Index of employed who feel they have a lot of say over what happens in job	0.991	85
	GDMS	Percentage of firms with intranet	55.4	
Micro (non-formal)				
Training provided as part of employment	CVTS	Average number of CVT course hours per employee	13	99
Work-related training	GPS	% of employed taking part in work-related self-directed learning in last 4 weeks	31.4	100
	GPS	% of employed taing part in work-related training by third party in last 4 weeks	31.2	117
ICT use in the workplace				
	GPS	Index of average time used on the internet in the workplace	122.81	119
Learning on-the-job	EWCS	Percentage of employed who feel they can get assistance from colleagues when asking for it	90.6	110
	EWCS	% of employed who thinks theirmainjob involves learning new things	75.3	105
	EWCS	% of employed who think their skills match the demands imposed by job	80.1	96
Micro (informal)				
ICT availability in the home	OECD	% of households with PC	38	94
	OECD	% of households with internet access	19	83
ICT use in the home	GPS	% of individuals using PC in the last 4 weeks	67.3	119
		Use of internet in the home by people with access (index)**	2.232	108
Participation in self-directed learning	GPS	Participation in self-directed learning for future job*****	12.3	
		Participation in training for future job*****	7.5	
ICT for learning purposes	GPS	% of adult learners using electronic learning materials*****	47.1	
Micro (formal)				
Participation in formal adult learning	OECD	Students aged 20-29 as % of the population aged 20-29	23.3	100
		Students aged 30-39 as % of the population aged 30-39	13	262
		Students aged 40+ as % of the population aged 40+	5.7	

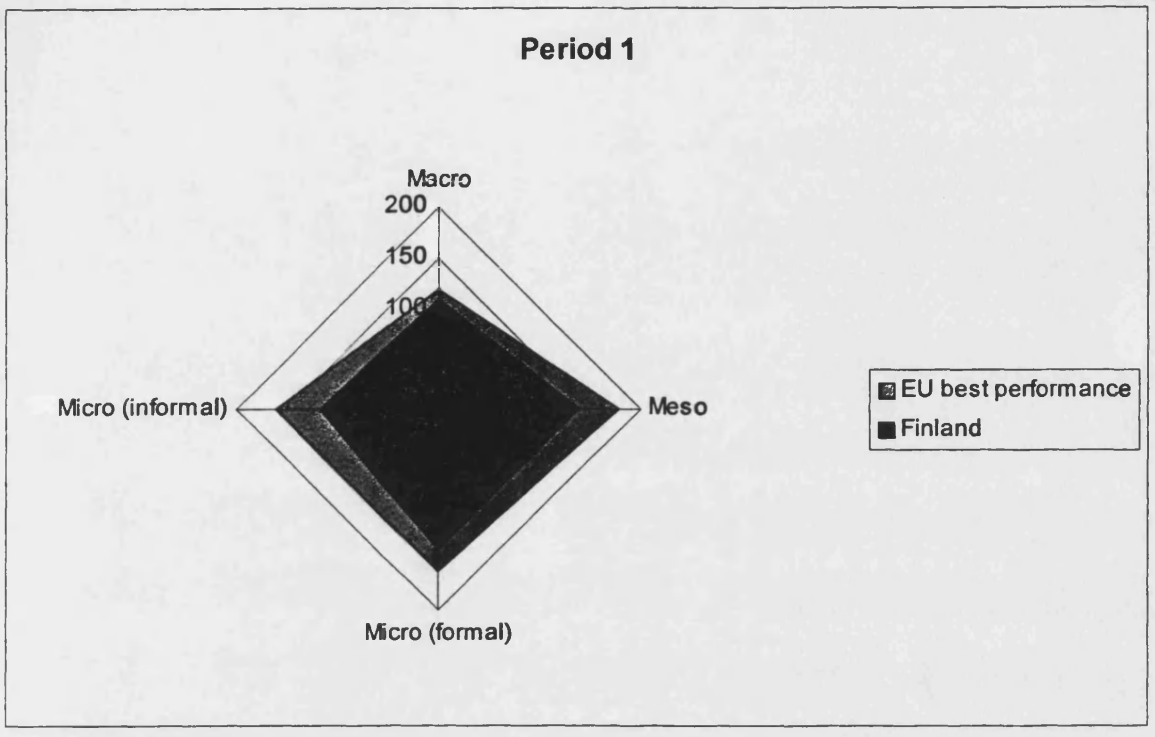
Annex 3 Radar Diagrams

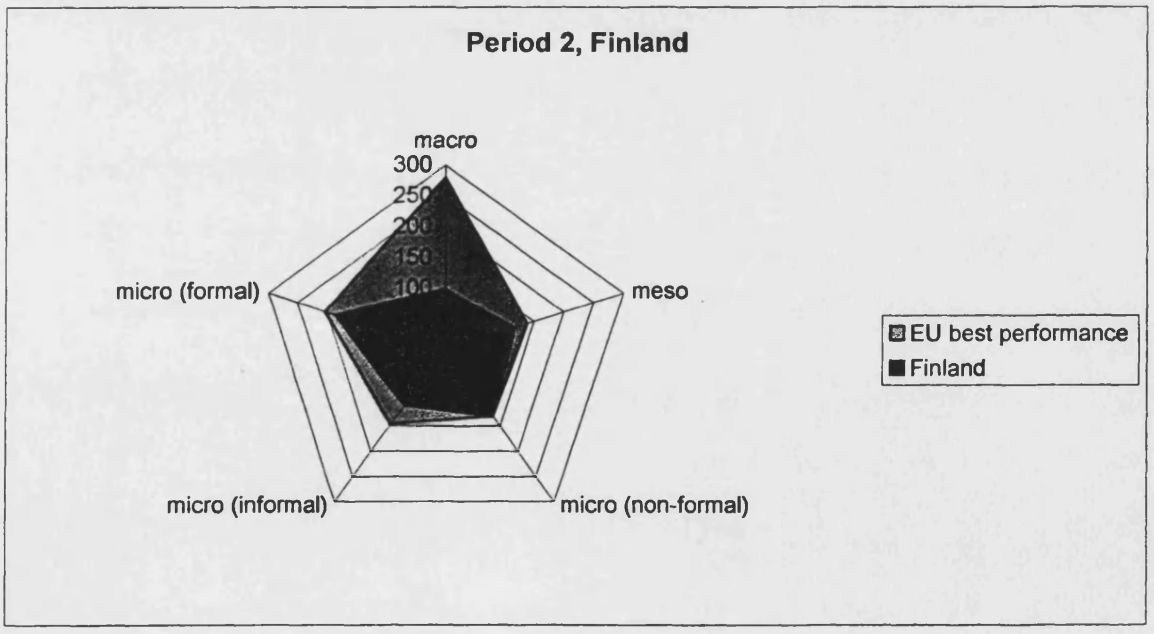
Austria



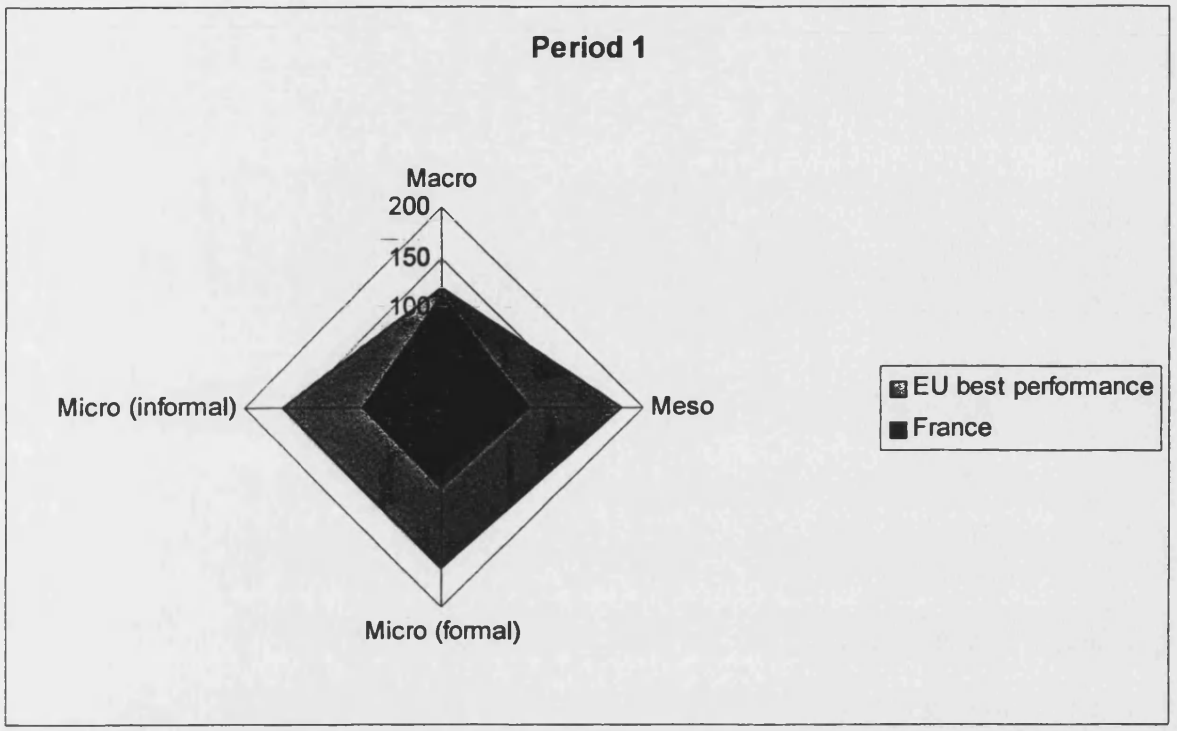


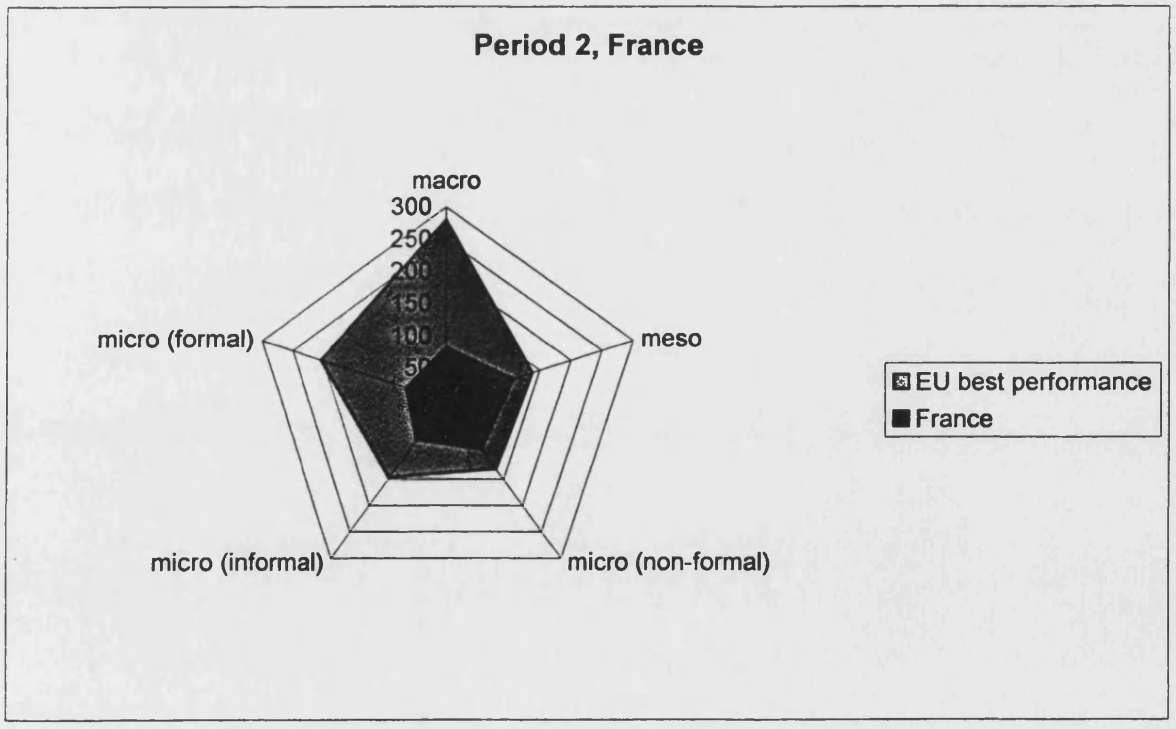
Finland


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Finland

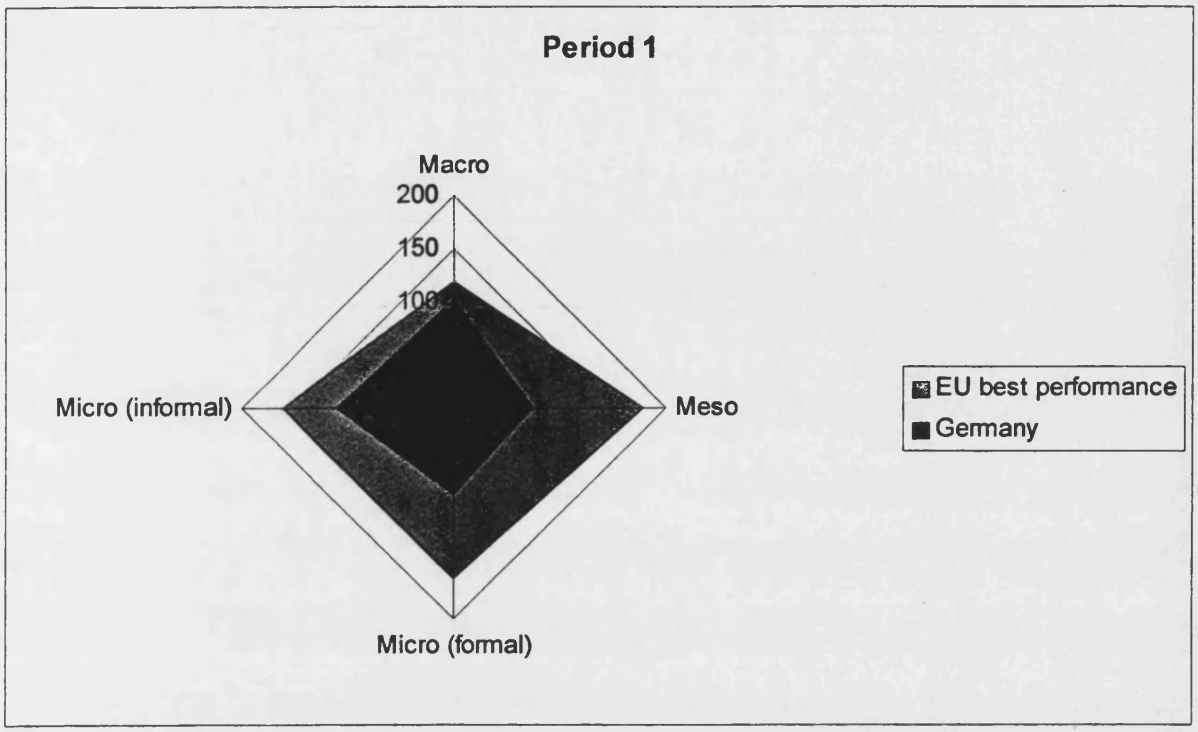

Period 2, Finland
macro
300
250
200
150
100
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
Finland

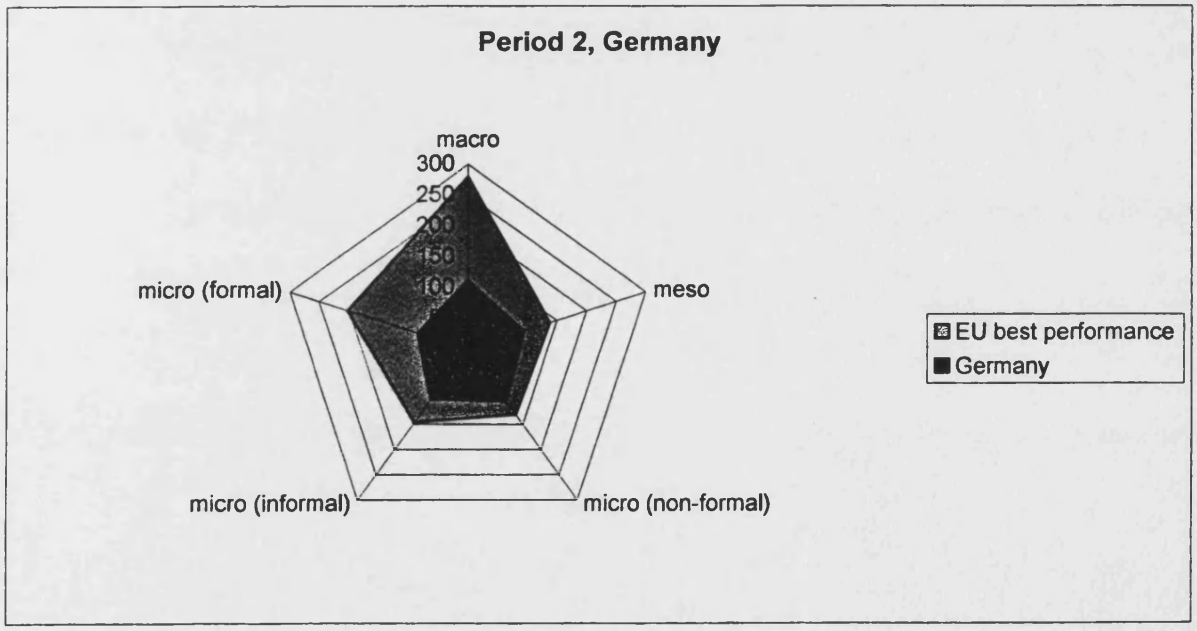
France


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
France

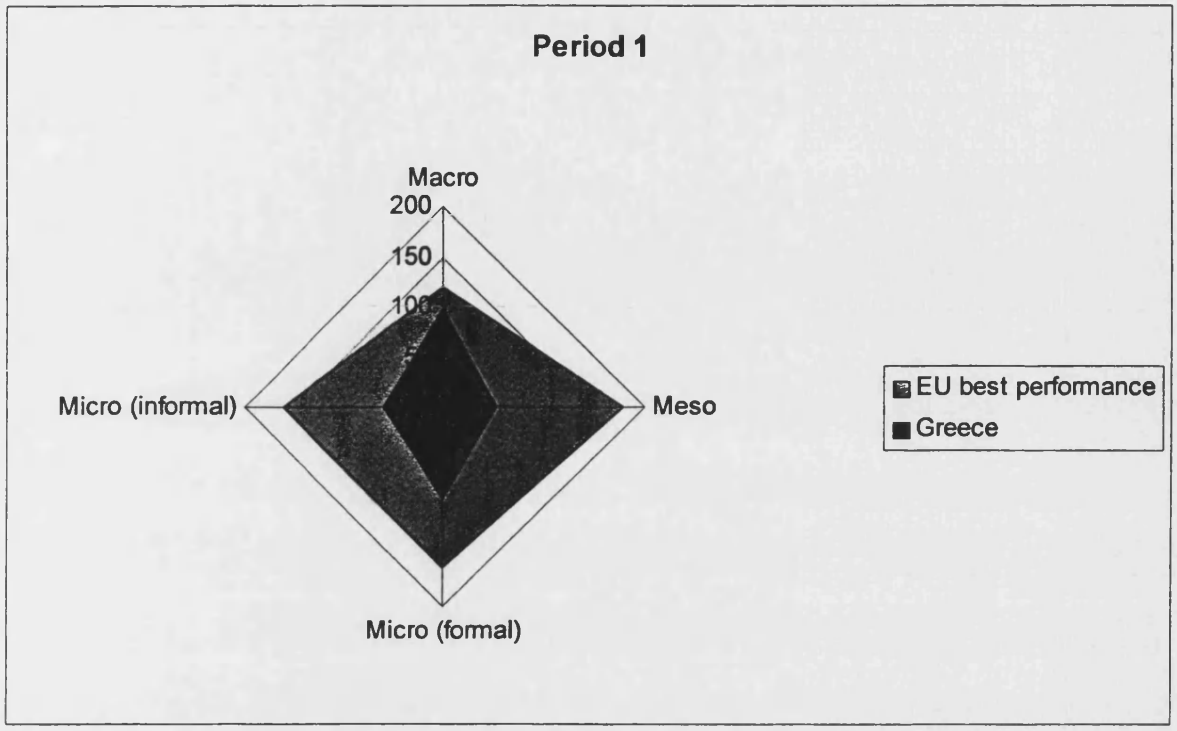

Period 2, France
macro
300
250
200
150
100
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
France

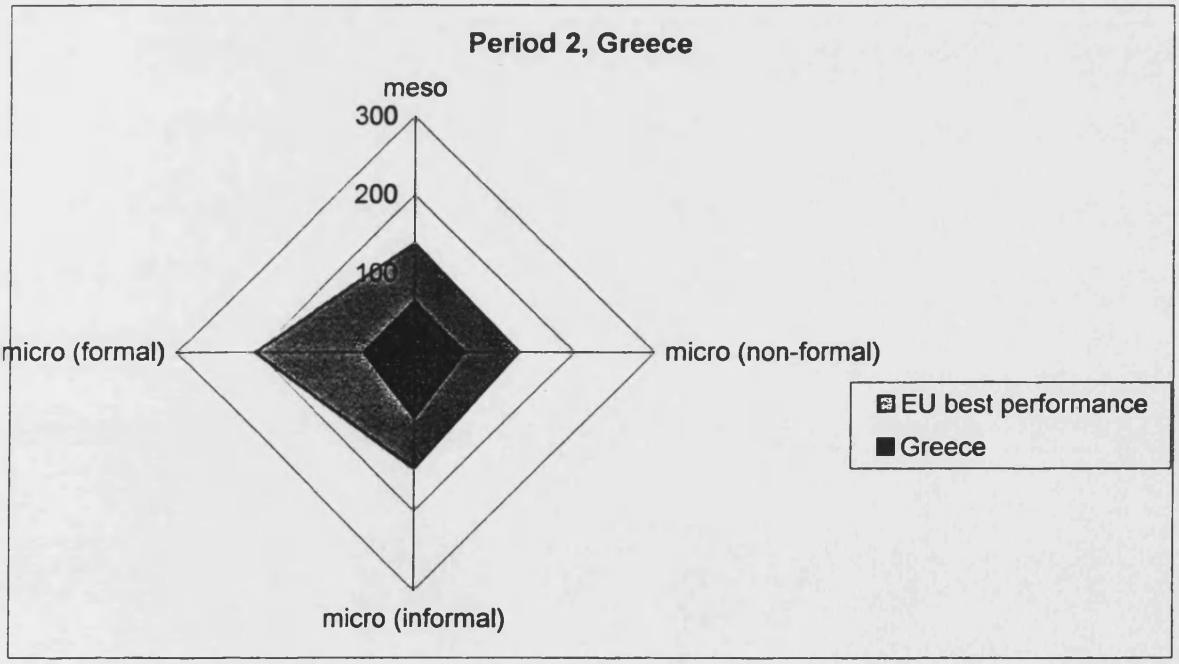
Germany


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Germany

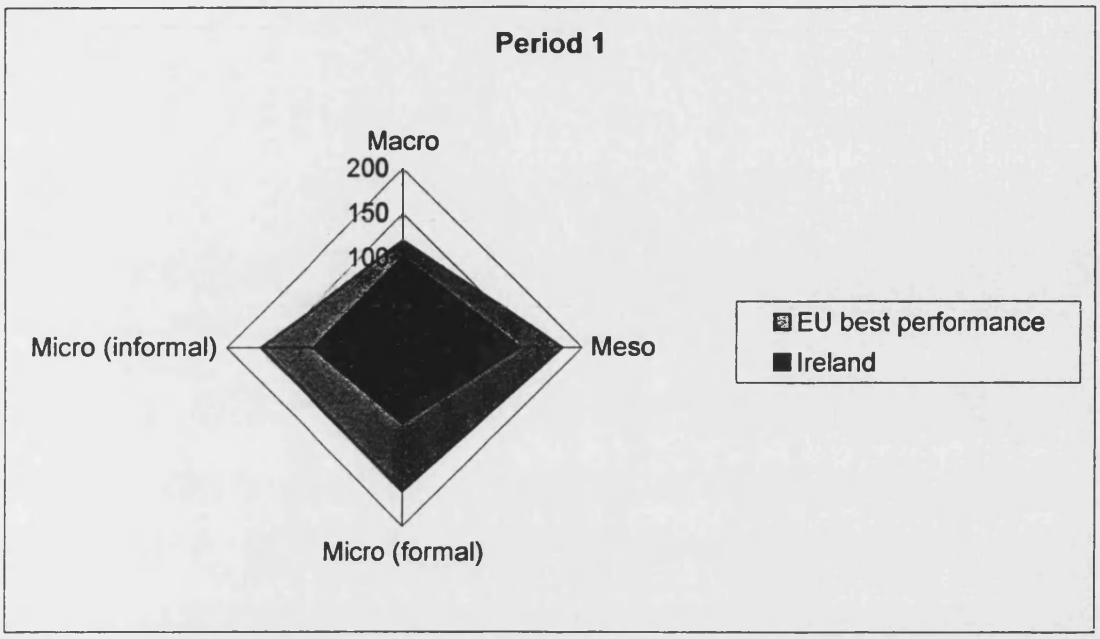

Period 2, Germany
macro
300
250
200
150
100
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
Germany

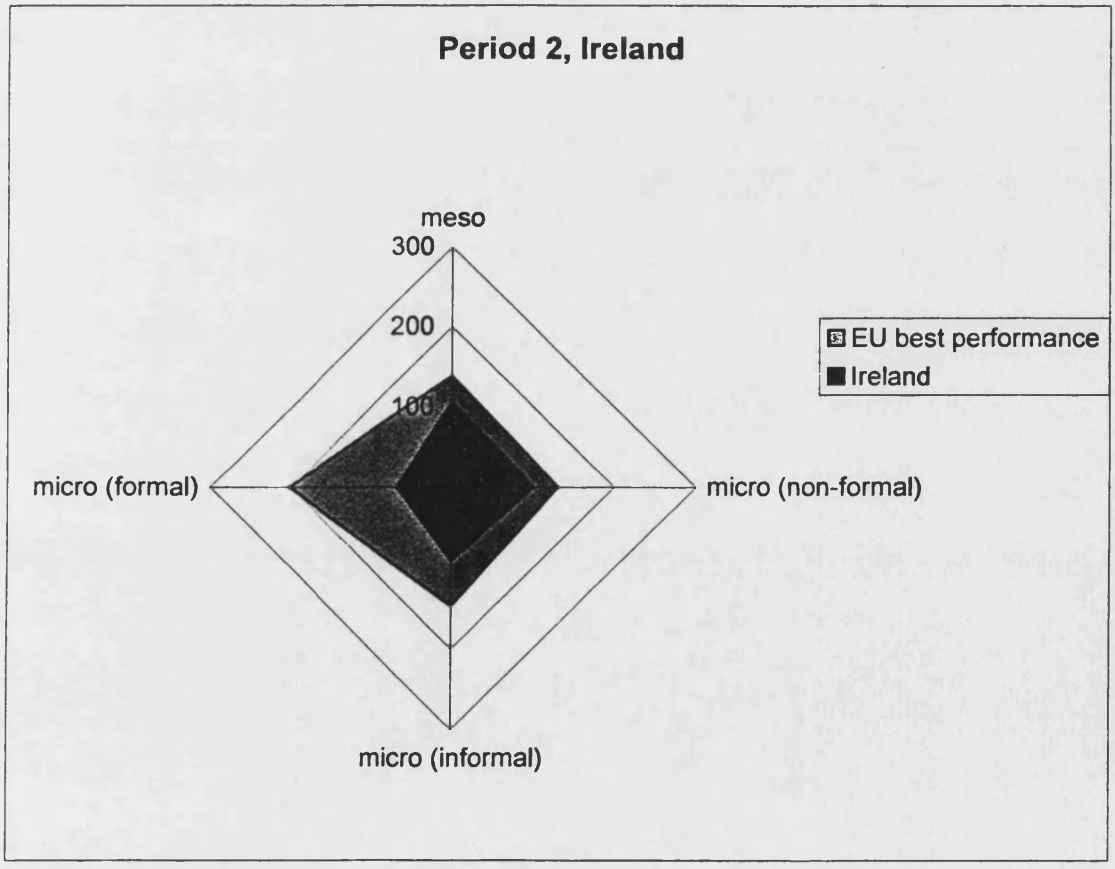
Greece


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Greece

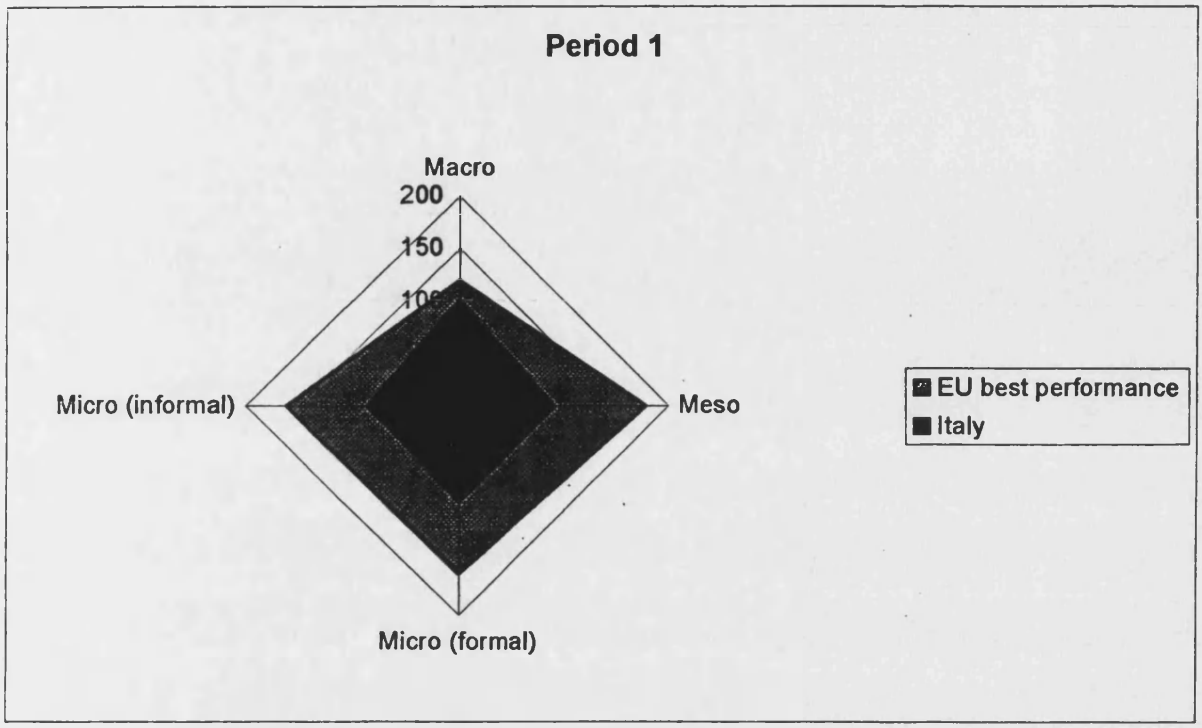

Period 2, Greece
meso
300
200
100
micro (formal)
micro (non-formal)
micro (informal)
EU best performance
Greece

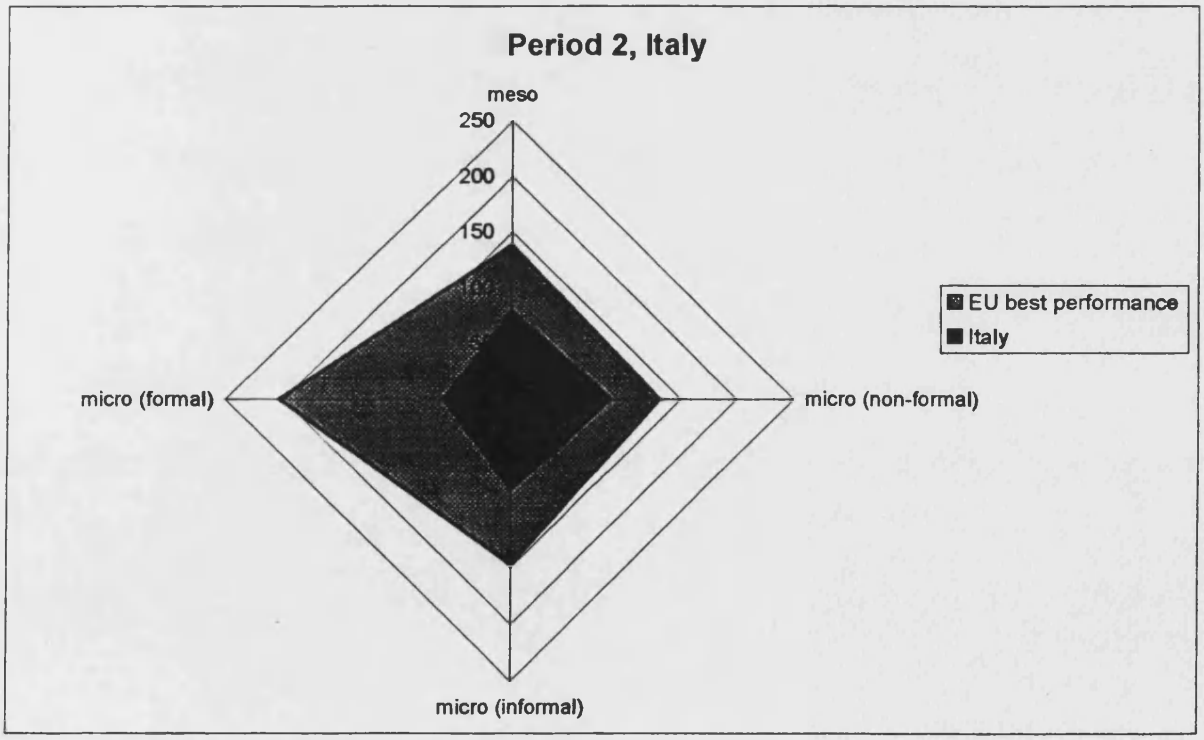
Ireland


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Ireland

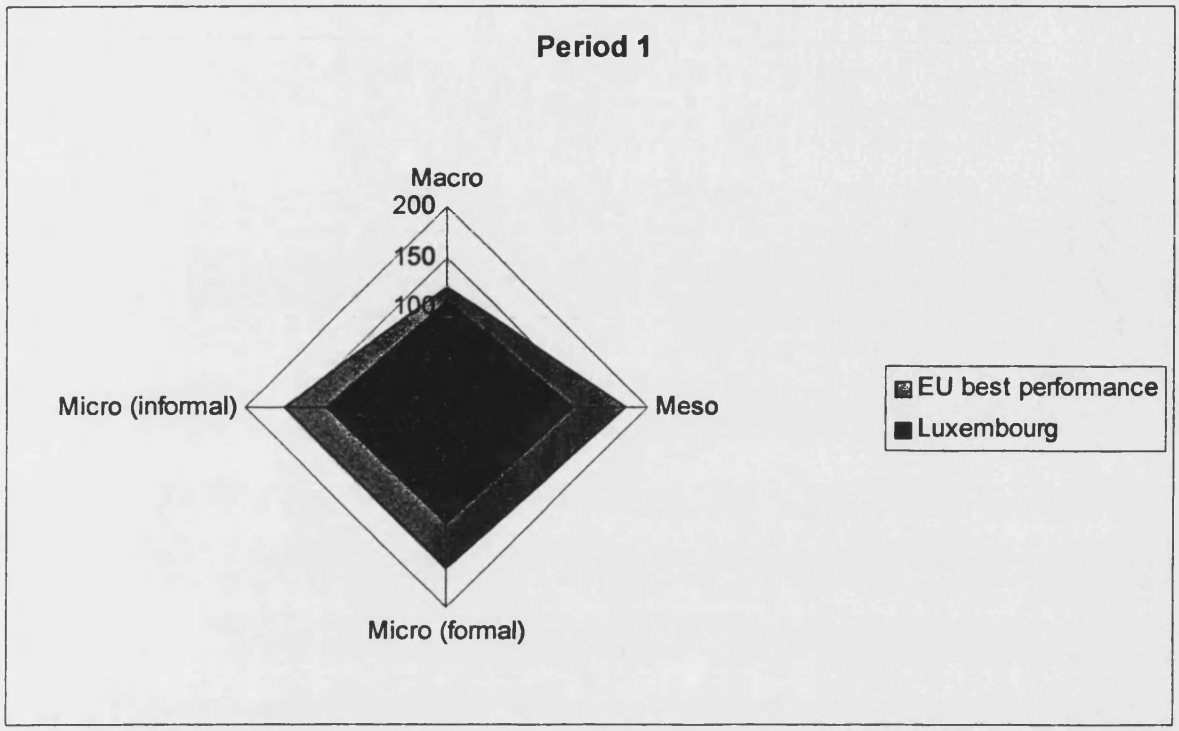

Period 2, Ireland
meso
300
200
100
micro (formal)
micro (non-formal)
micro (informal)
EU best performance
Ireland

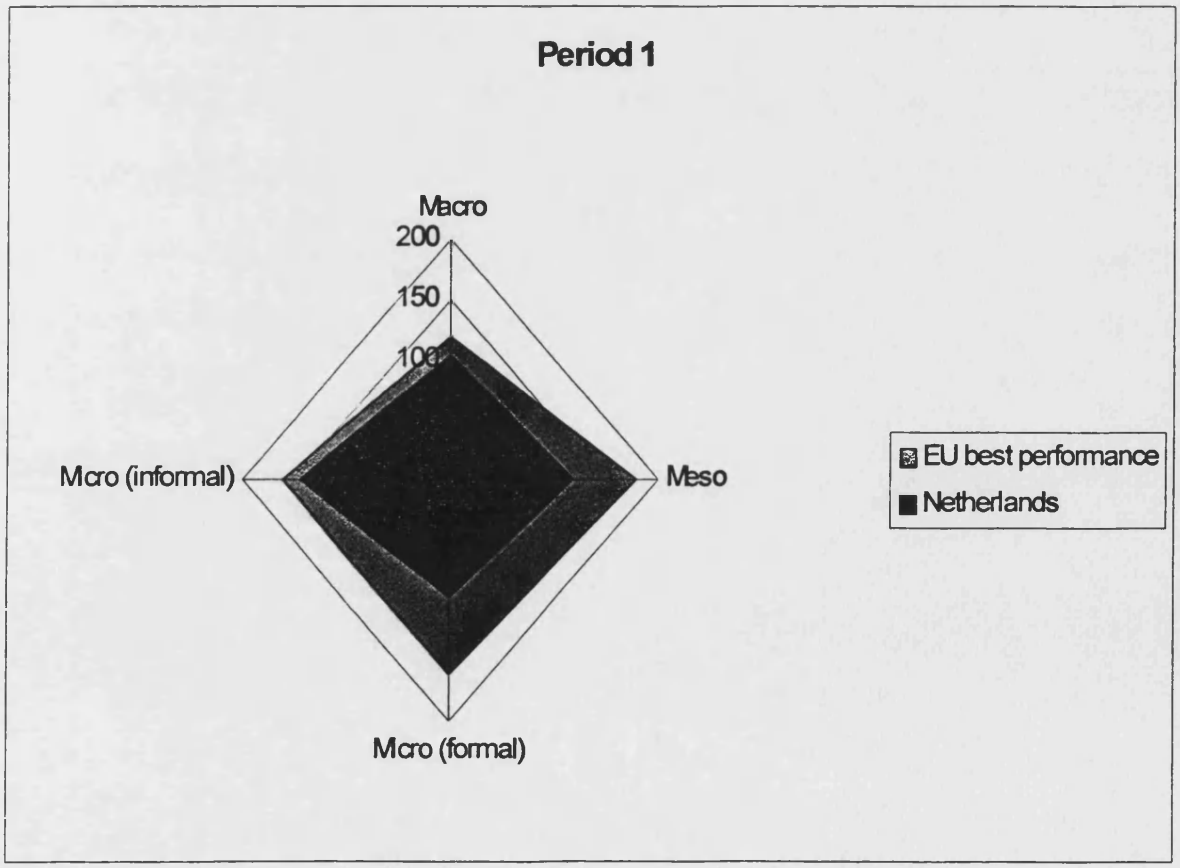
Italy


Period 1
Macro
200
150
Micro (informal)
Meso
Micro (formal)
EU best performance
Italy

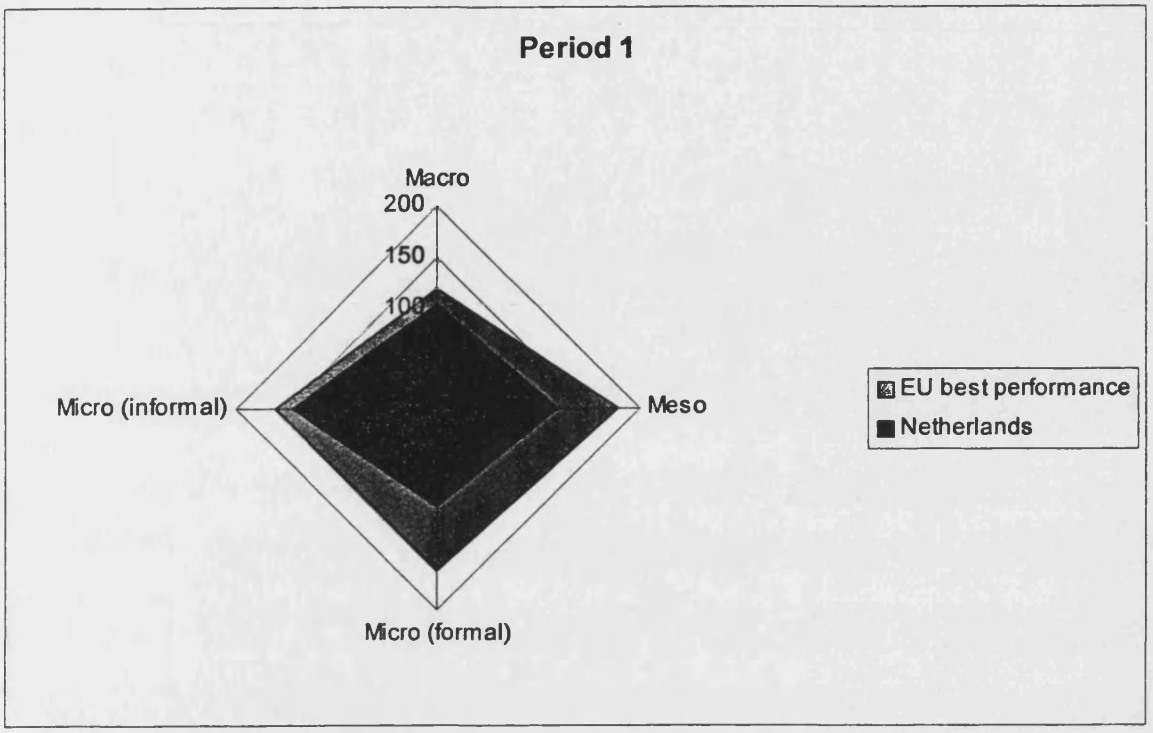

Period 2, Italy
meso
250
200
150
micro (formal)
micro (non-formal)
micro (informal)
EU best performance
Italy

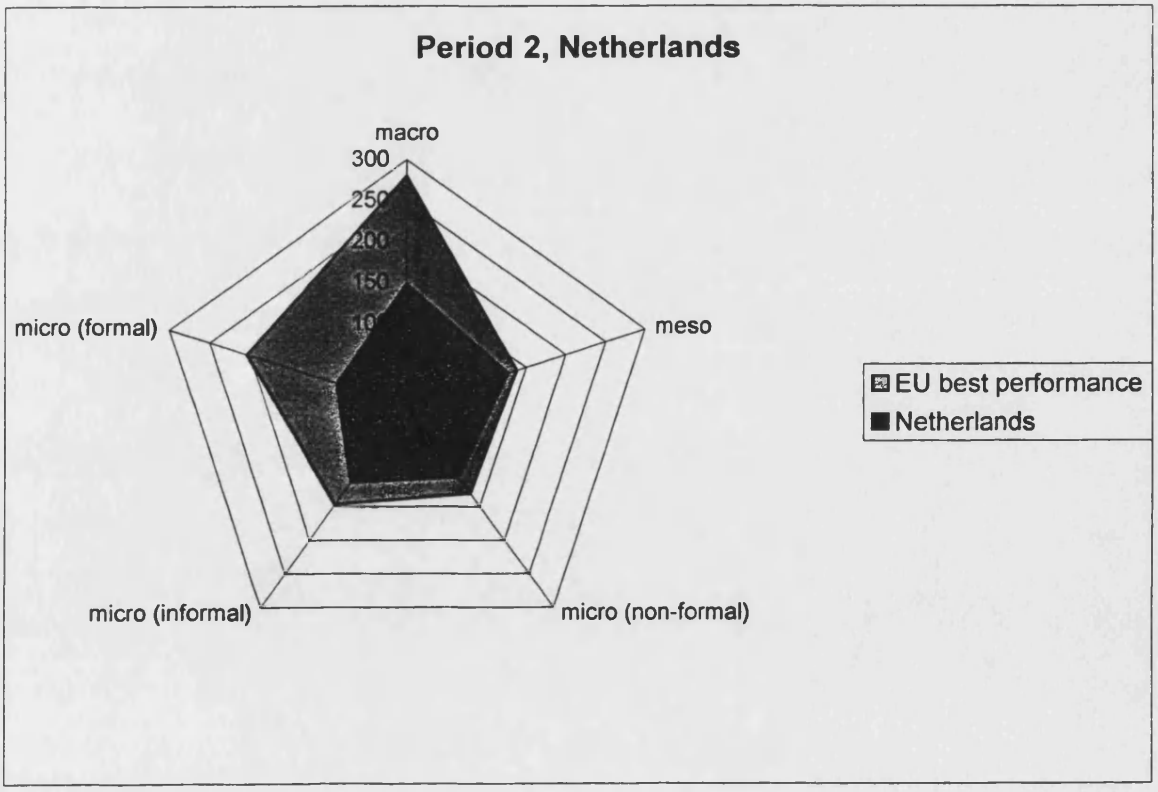
Luxembourg


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Luxembourg

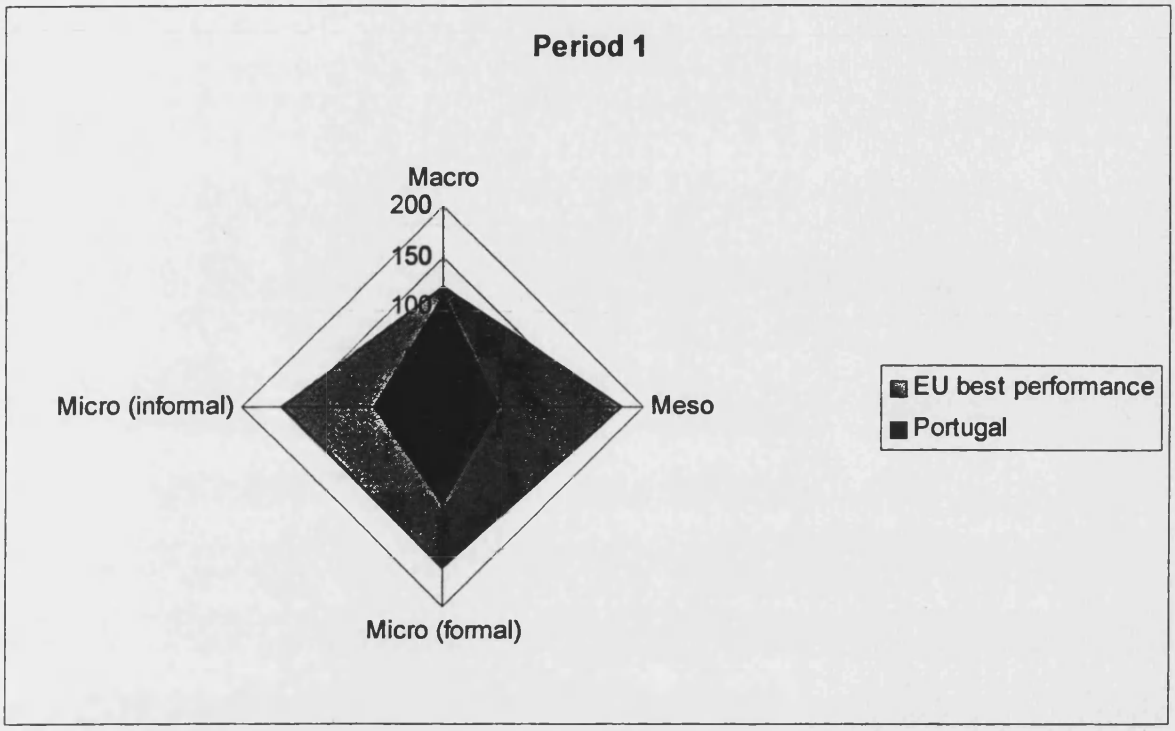

Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Netherlands

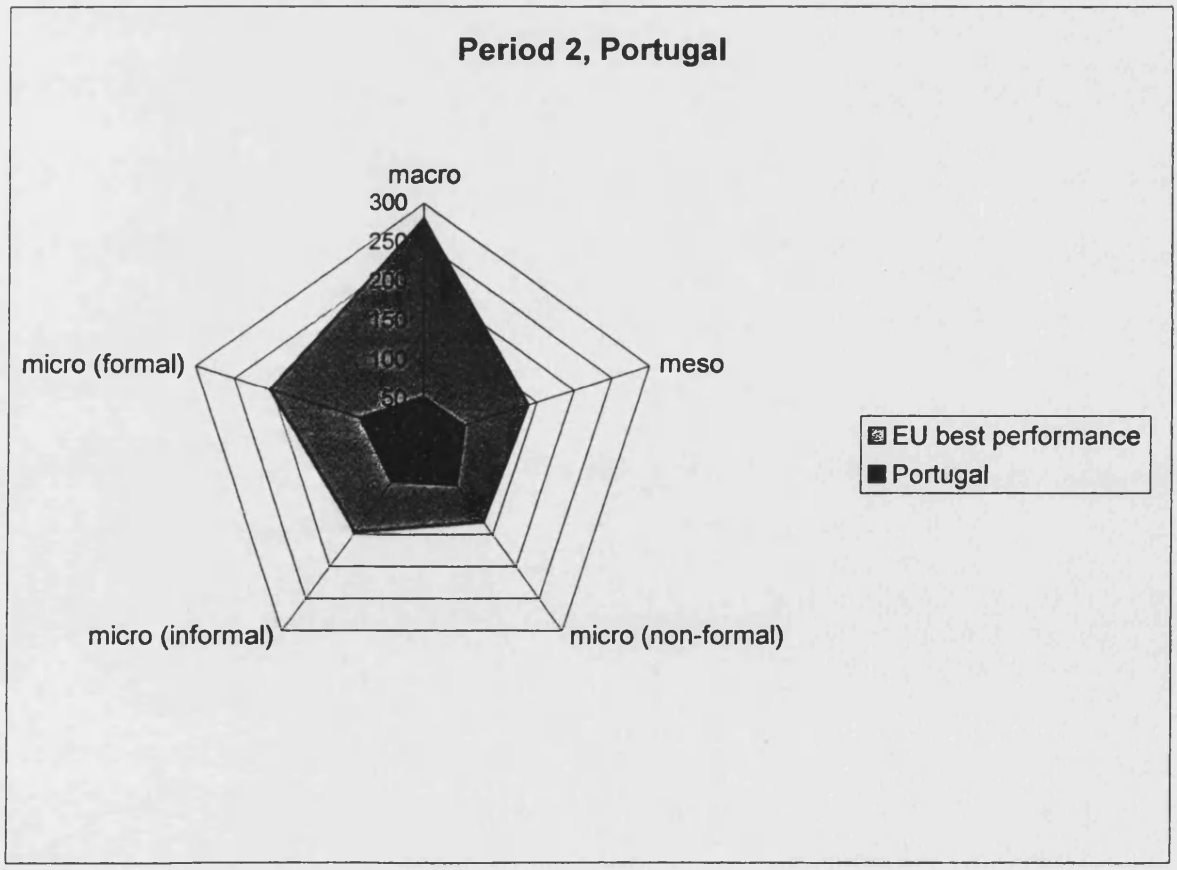
Netherlands



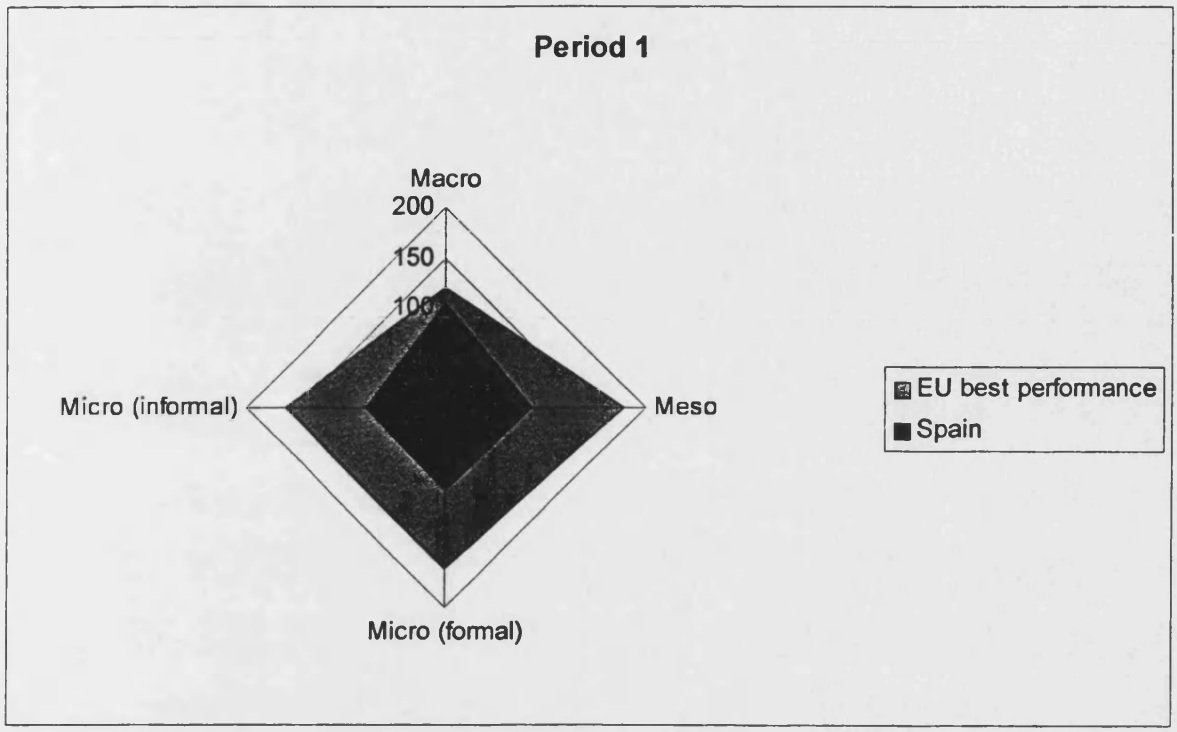


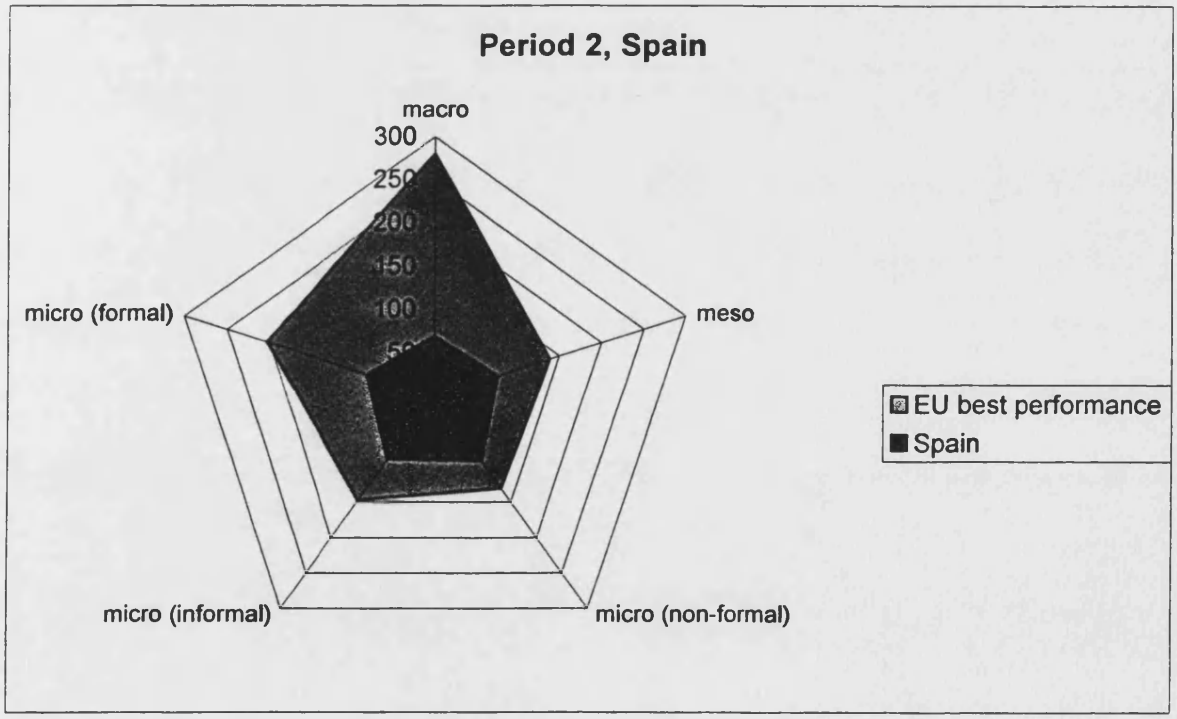
Portugal


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Portugal

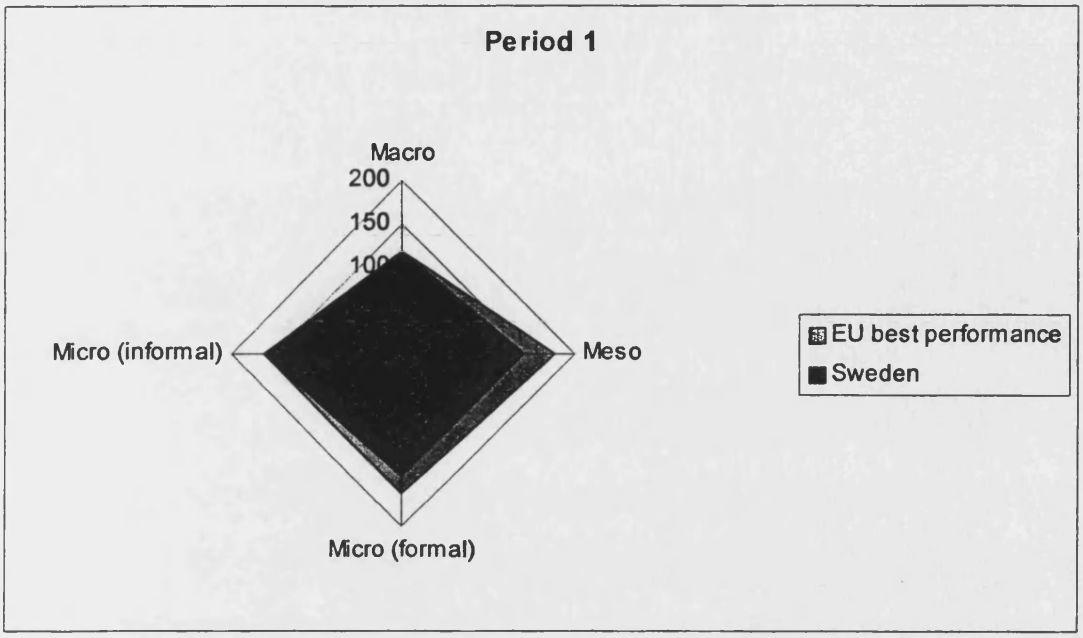

Period 2, Portugal
macro
300
250
200
150
100
50
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
Portugal

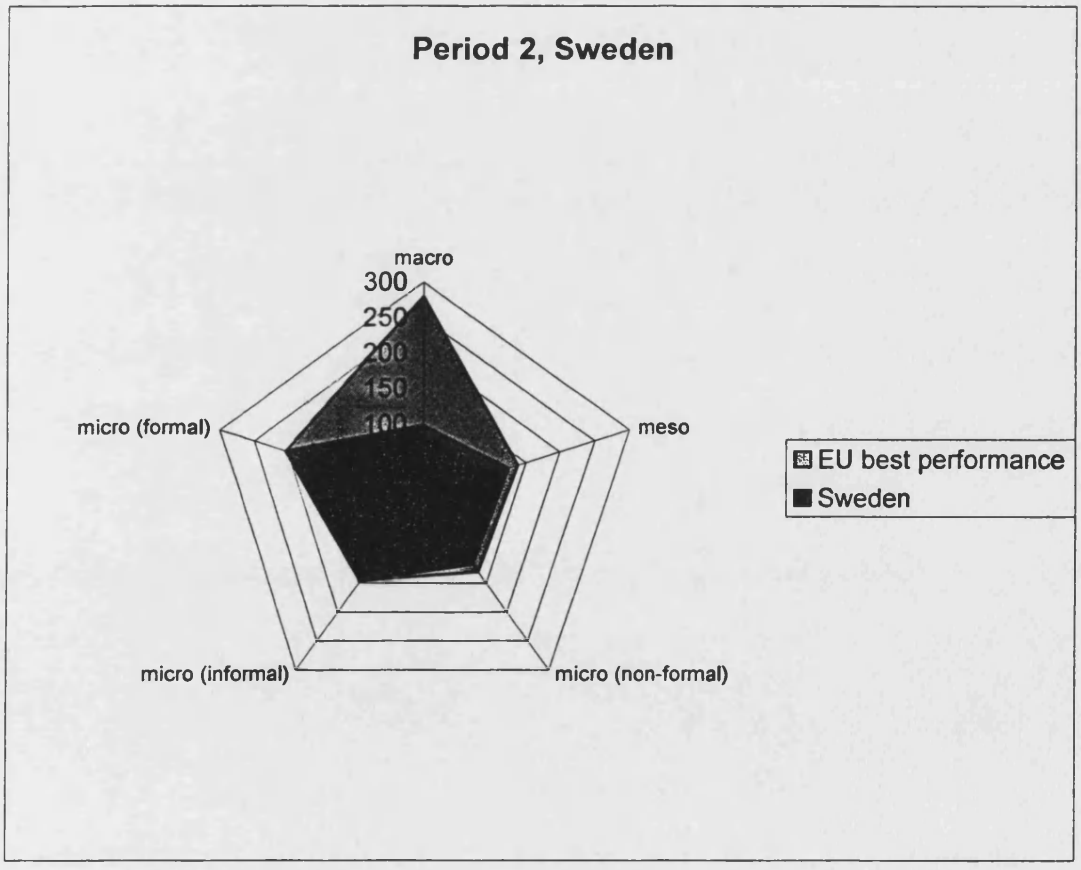
Spain


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Spain

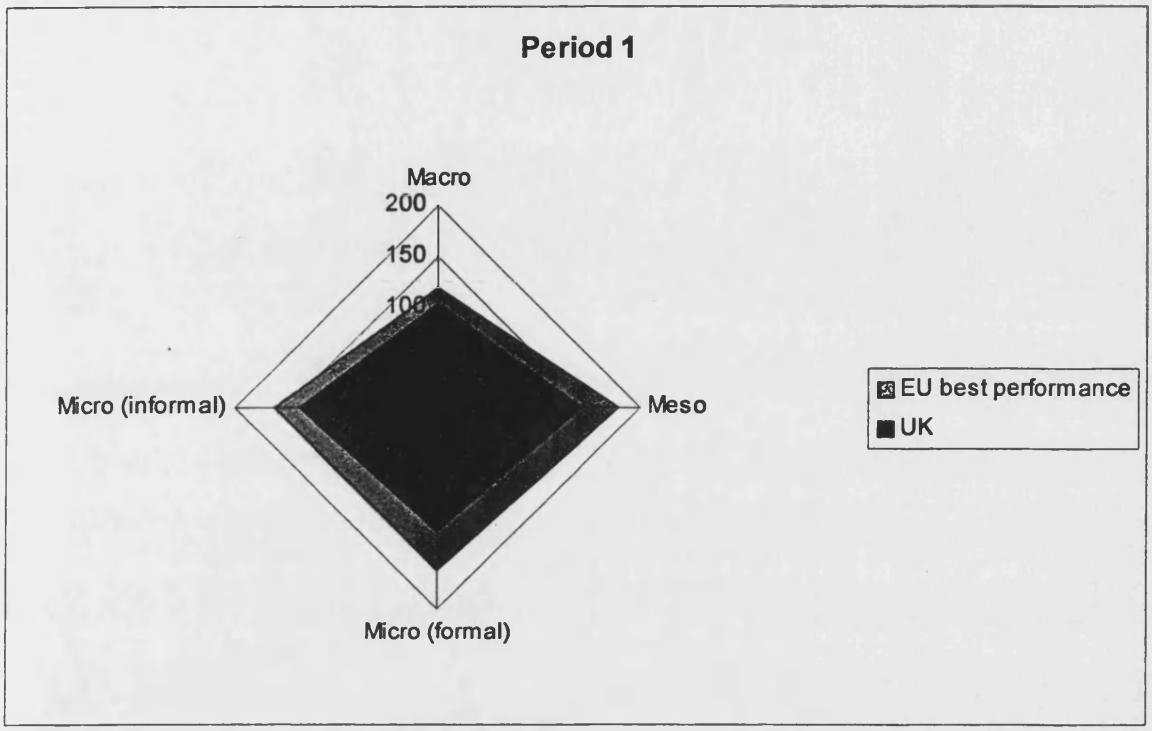

Period 2, Spain
macro
300
250
200
150
100
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
Spain

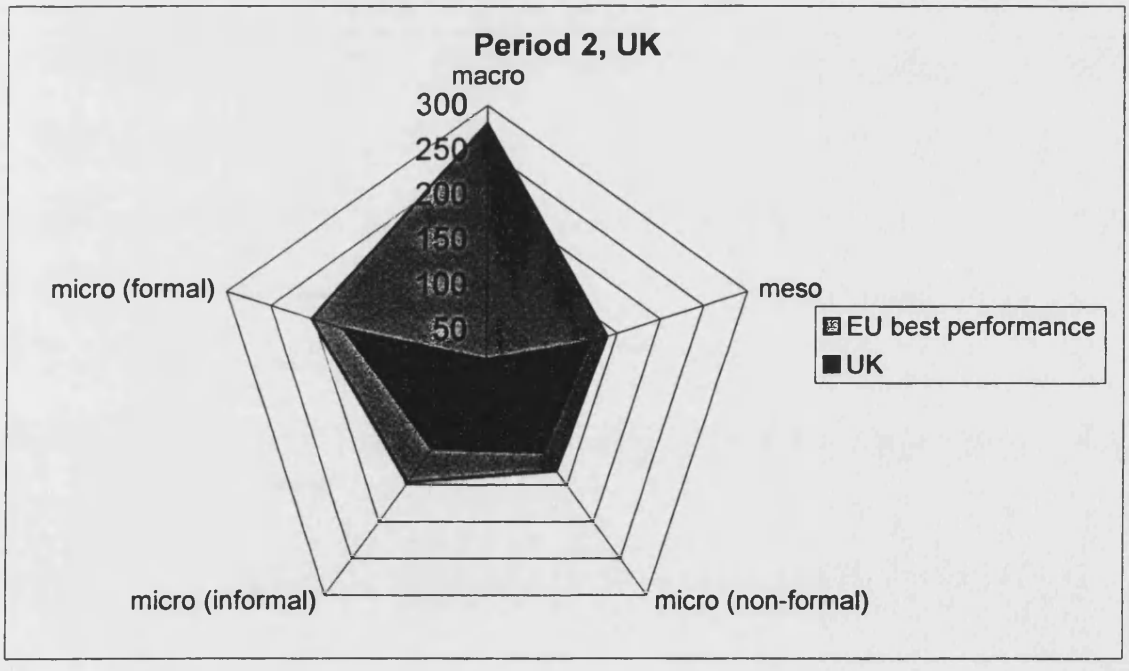
Sweden


Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
Sweden

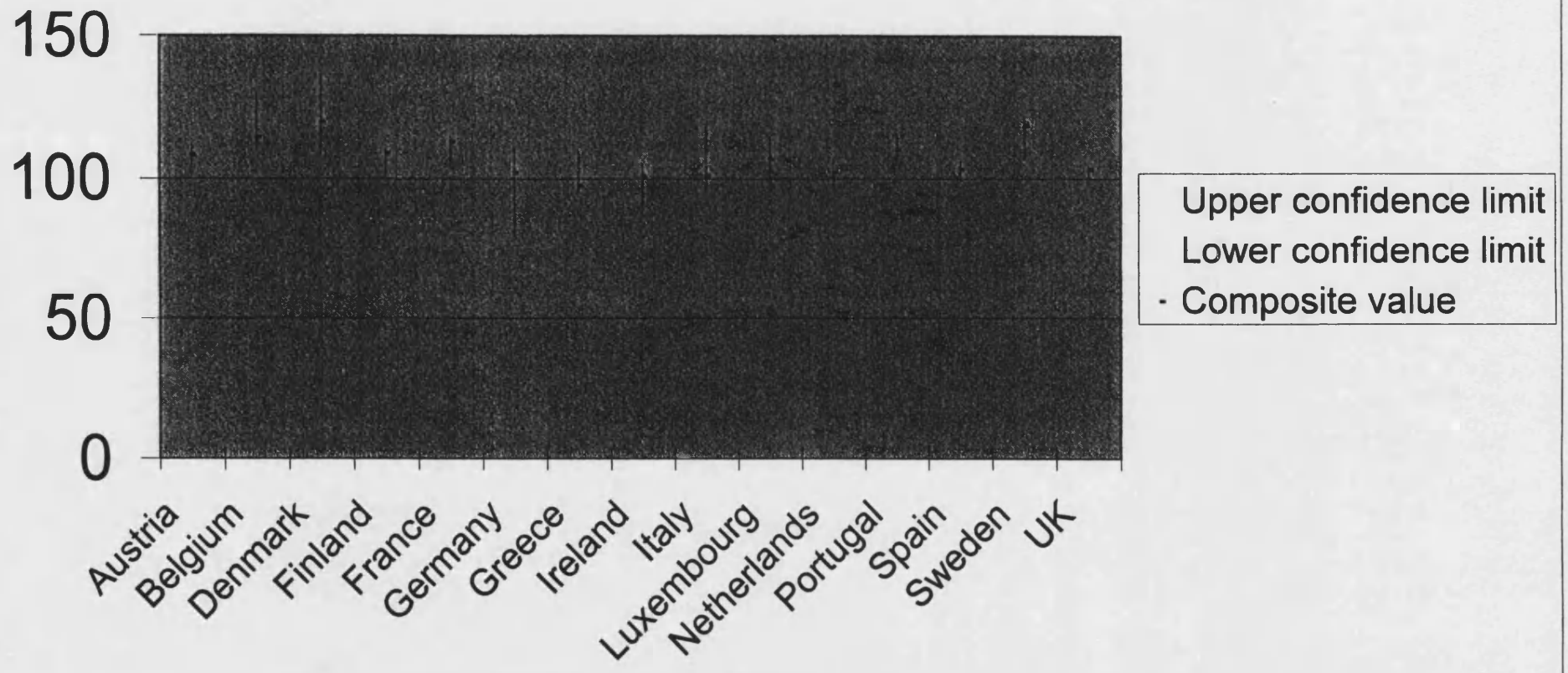

Period 2, Sweden
macro
300
250
200
150
100
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
Sweden

UK

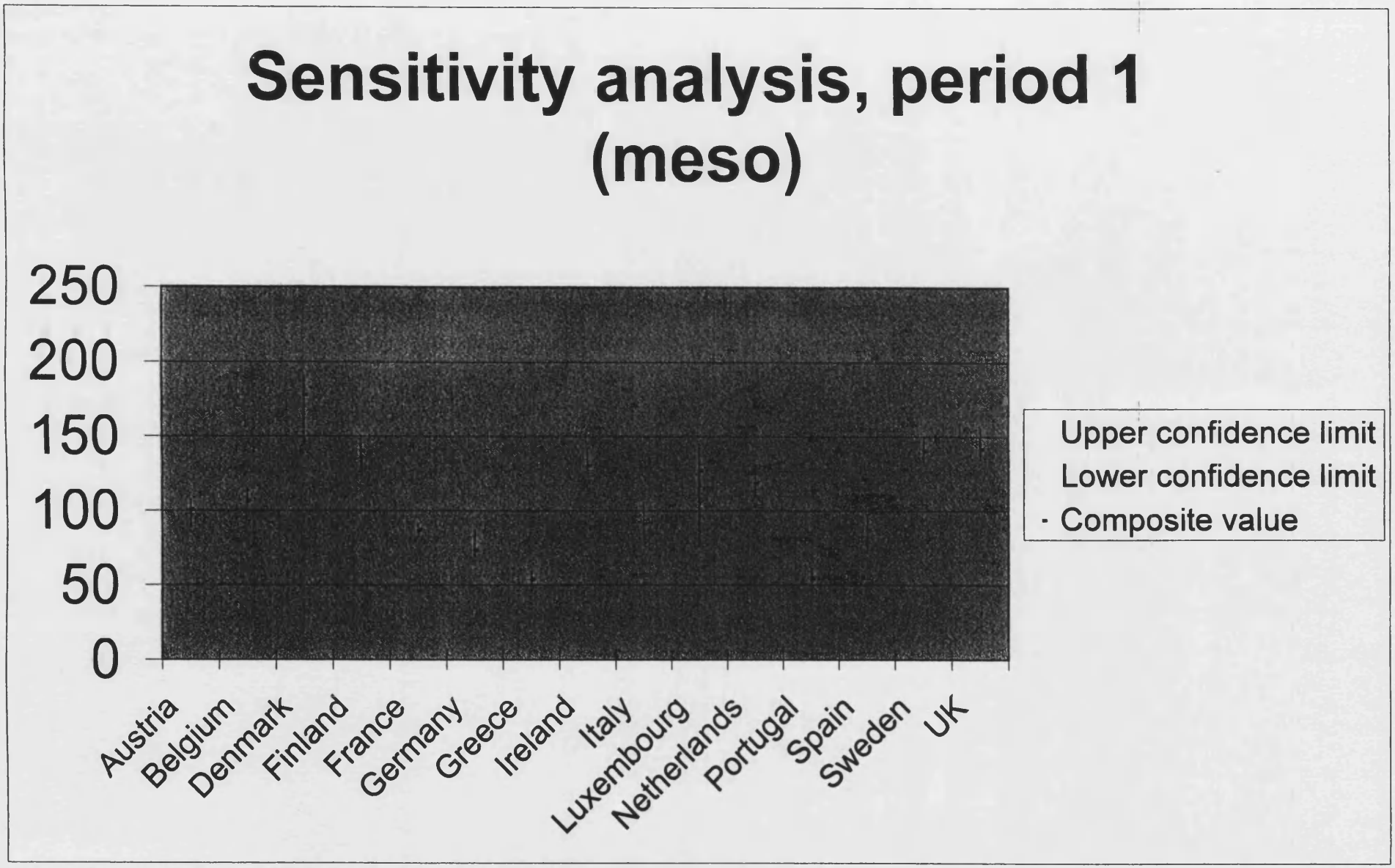

Period 1
Macro
200
150
100
Micro (informal)
Meso
Micro (formal)
EU best performance
UK

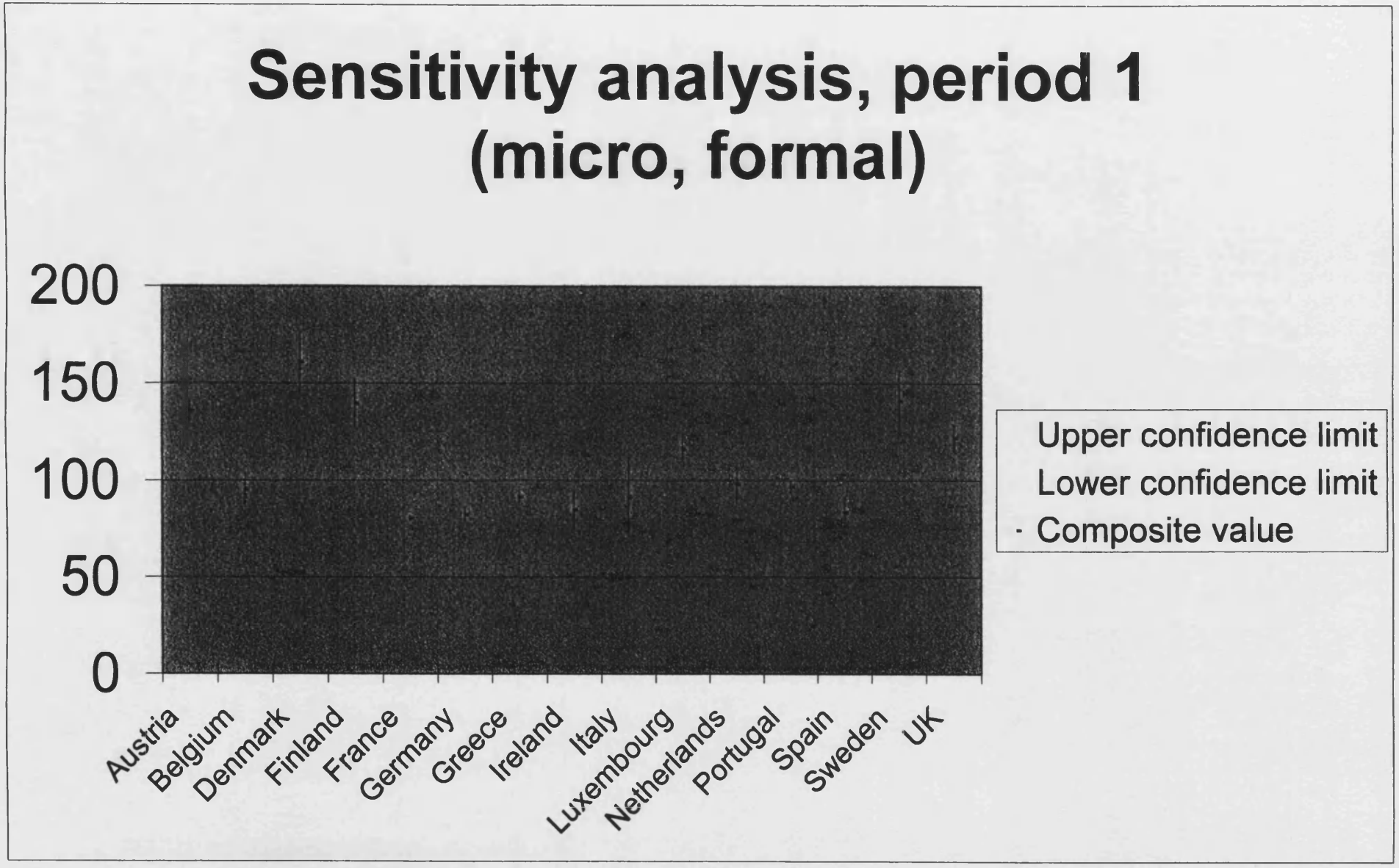

Period 2, UK
macro
300
250
200
150
100
50
micro (formal)
meso
micro (informal)
micro (non-formal)
EU best performance
UK

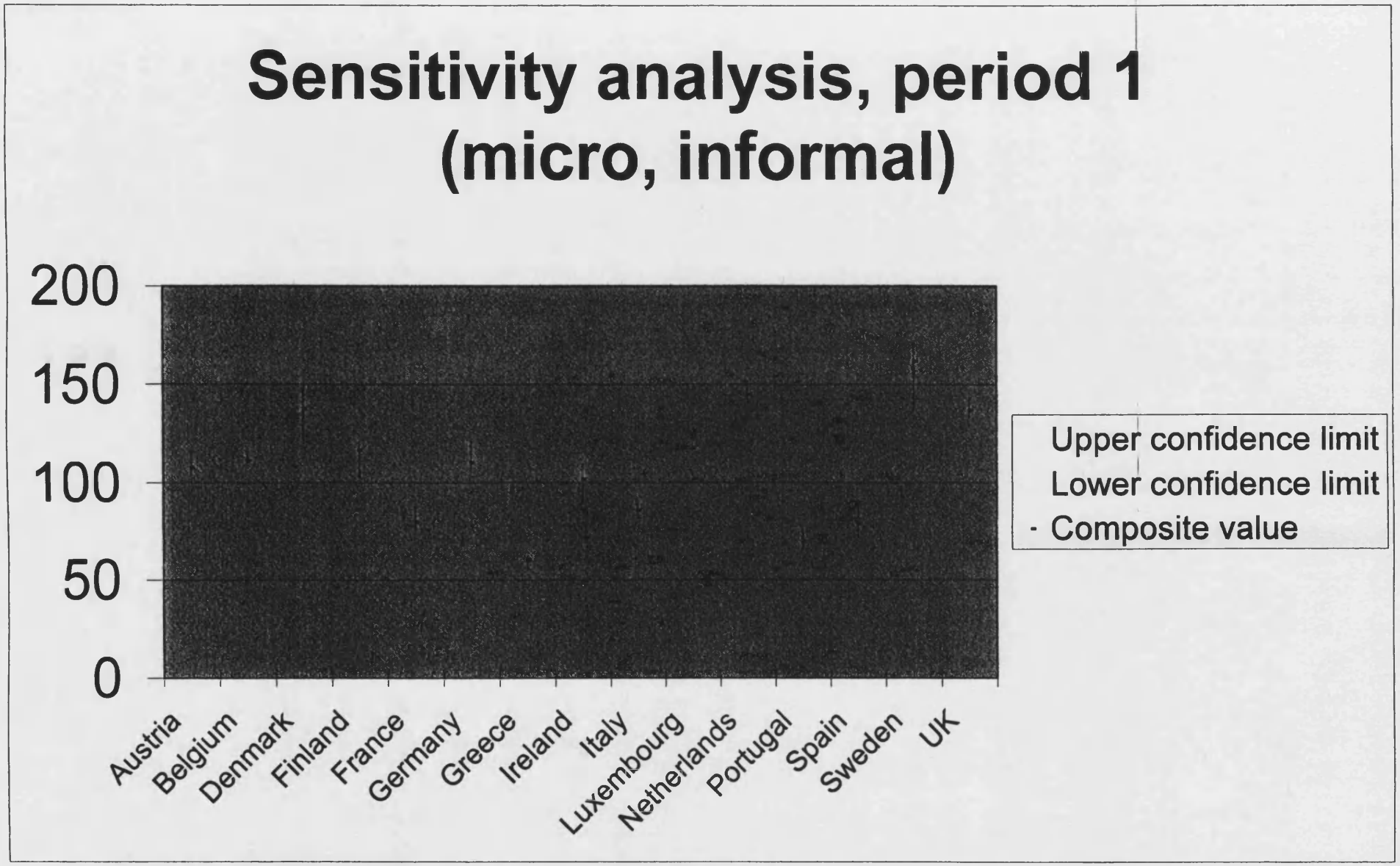
Sensitivity analysis, period 1 (macro)

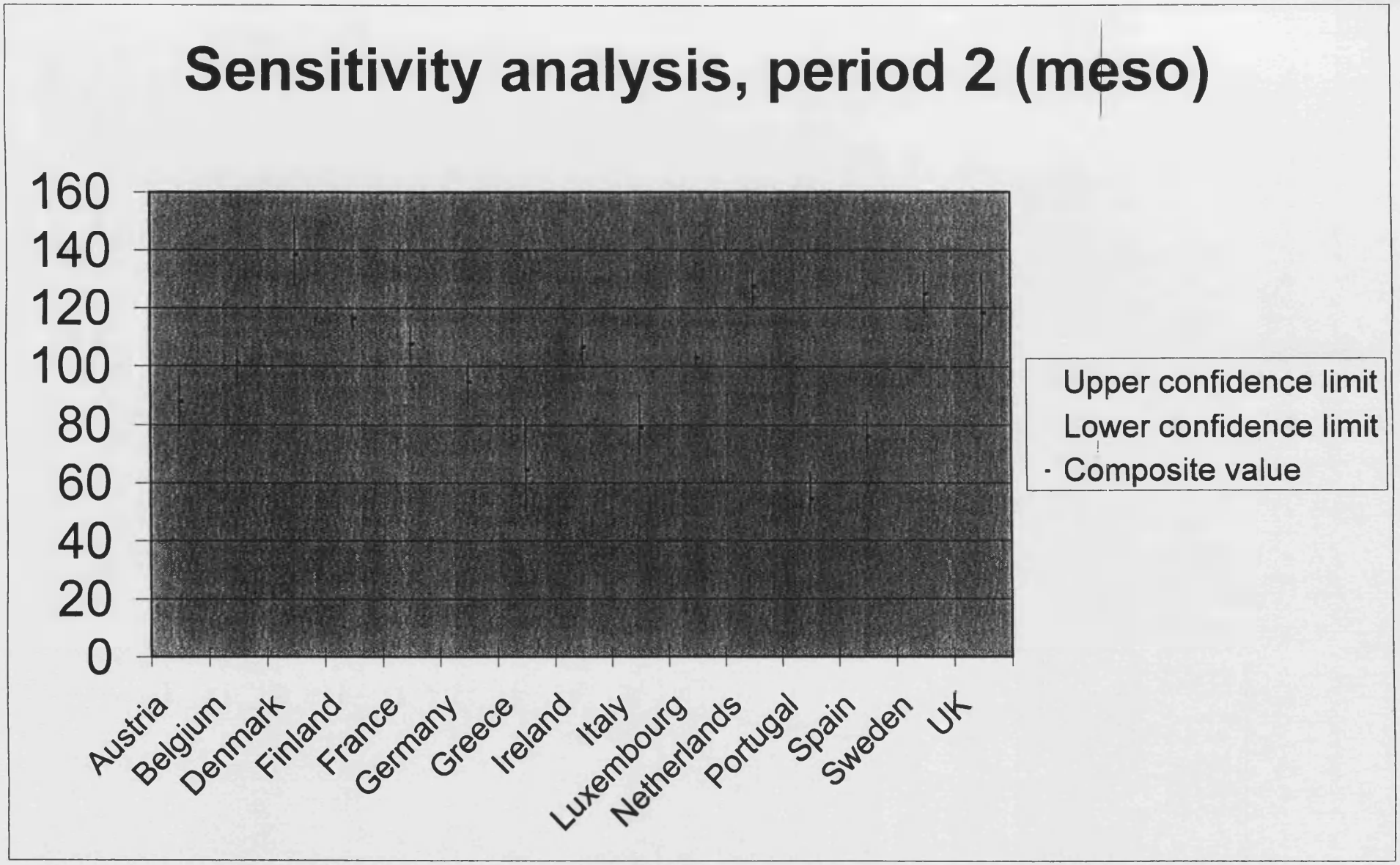


Annex 4

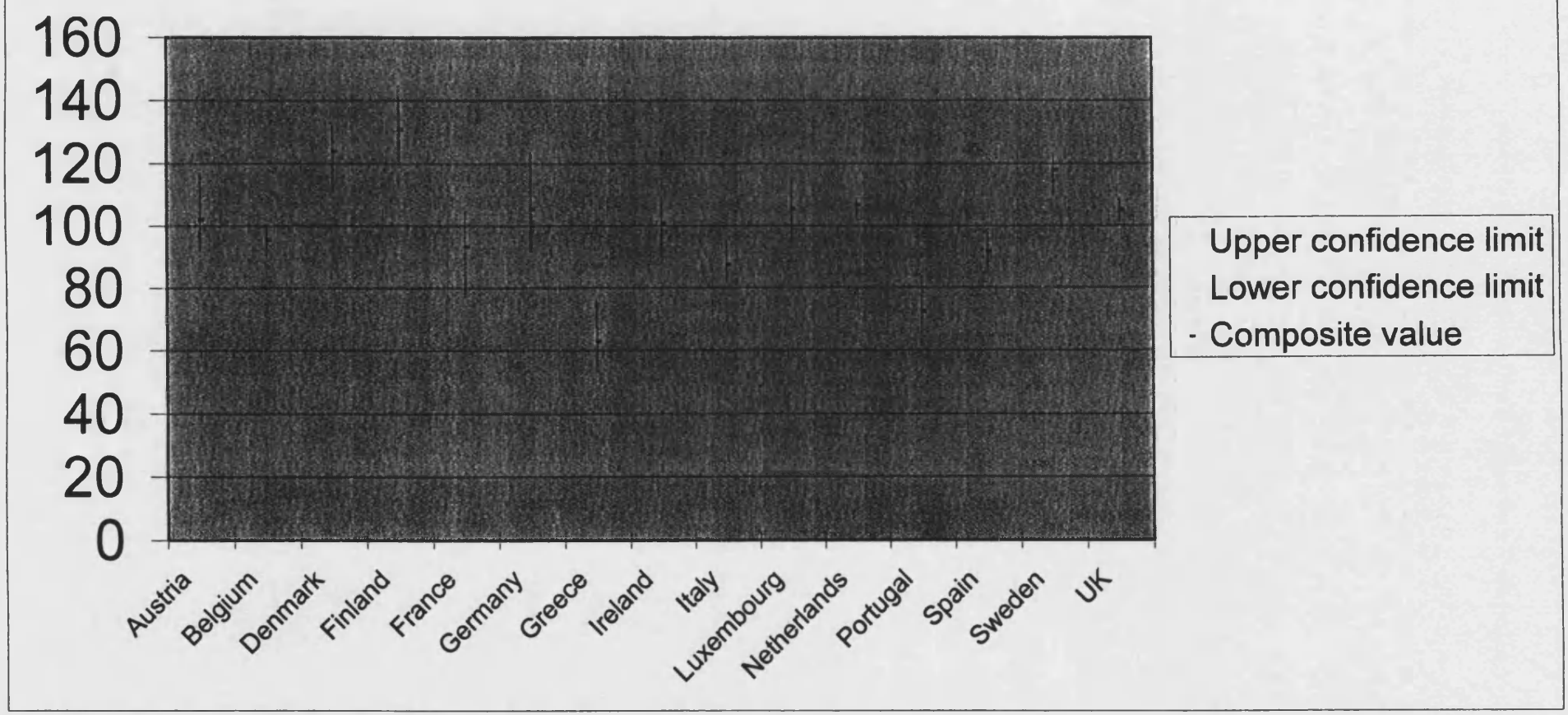

Sensitivity analysis, period 1 (meso)
250
200
150
100
50
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value

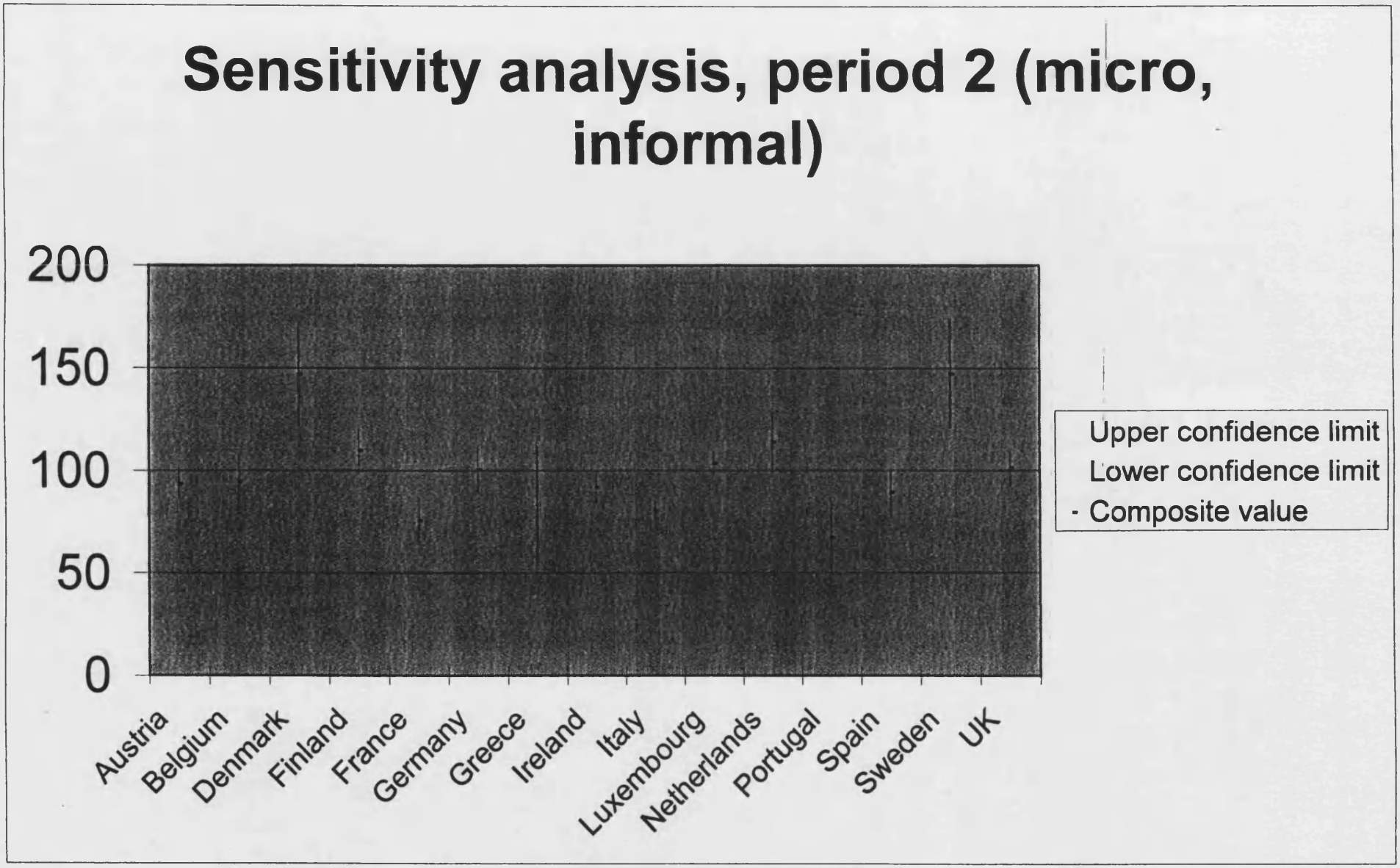

Sensitivity analysis, period 1
(micro, formal)
200
150
100
50
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value

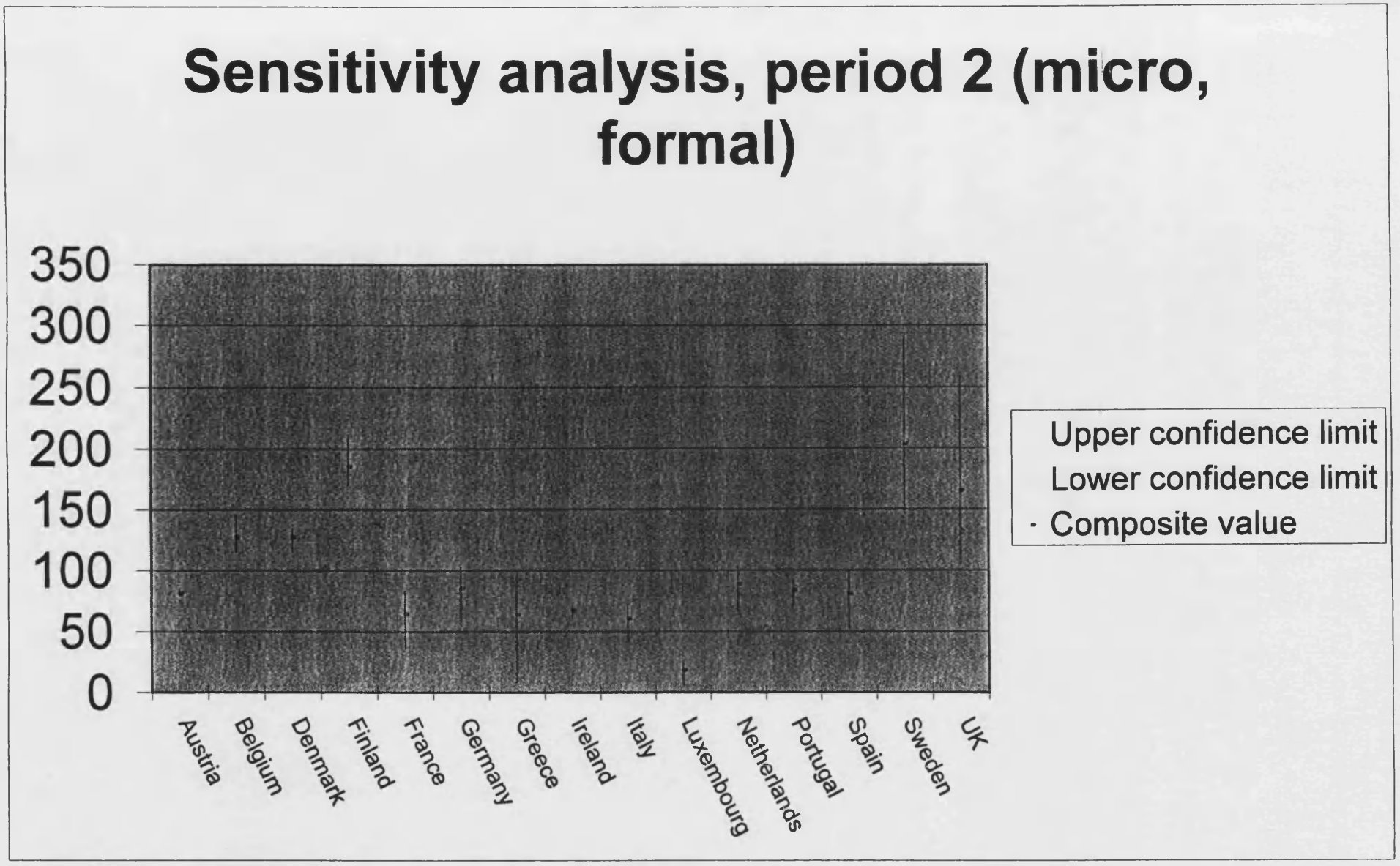

Sensitivity analysis, period 1
(micro, informal)
200
150
100
50
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value


Sensitivity analysis, period 2 (meso)
160
140
120
100
80
60
40
20
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value

Sensitivity analysis, period 2 (micro, non-formal)




Sensitivity analysis, period 2 (micro, informal)
200
150
100
50
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value


Sensitivity analysis, period 2 (micro, formal)
350
300
250
200
150
100
50
0
Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
UK
Upper confidence limit
Lower confidence limit
Composite value

Annex 5

Period 1

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	32.59373	31.31555	37.06738	33.23283	34.51101	29.39827	24.92462	28.75918	26.8419		27.48099	33.23283	28.75918	38.98466	30.67645
Indicator 2	30.96291	31.43347	30.49235	29.33164	31.68444	31.4021	30.77469	31.55896	31.18251	28.92382	31.15114	33.56668	32.50008	30.77469	30.96291
Indicator 3	29.45592	34.85681	31.75417	32.67347	33.17143	34.24394	29.49423	30.98809	27.65562	29.91557	33.01821	28.07697	30.68166	33.09482	28.61323
Indicator 4	33.88381	42.1983	44.17999	28.63591	28.15697	15.60308	33.95575	22.22815	39.68525	35.22722	27.69378	33.88381	27.98453	30.29007	29.39919

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	35.02366	27.90948	37.21264	41.59059	24.07876	19.15356	21.88979	40.4961	31.74019	22.43703	33.92917	20.24805	34.47641	34.47641	39.78855
Indicator 2	33.99464	26.87948	46.64381	44.27209	22.92662	17.39261	18.97375	38.73808	26.08891	16.60203	27.67006	16.60203	37.15693	41.1098	43.49856
Indicator 3	31.58191	29.28504	87.85512	47.65997	27.27528	14.0683	14.0683	31.2948	15.79095	92.44886	35.88853	11.48433	20.67179	43.92756	31.31219
Indicator 4	26.25692	33.18584	35.73859	36.10327	30.63308	34.27987	16.41058	35.73859	32.45648	33.55051	33.91519	22.61013	34.27987	36.46795	34.03924
Indicator 5	31.87591	35.41767	46.75133	19.8339	26.91743	28.33414	12.75036	29.75085	42.50121	34.70932	31.16755	17.70884	24.79237	50.2931	43.84655
Indicator 6	31.10768	36.51771	42.82942	42.37858	27.50099	23.89431	9.918391	37.41939	31.10768	16.23009	40.57524	18.03344	19.83678	36.51771	44.29589
Indicator 7	29.23629	29.93239	57.77647	54.29596	22.27527	25.05967	7.657123	49.42325	22.97137	25.05967	26.45188	14.61814	15.31425	45.94274	41.03638
Indicator 8	12.78616	39.15763	40.7559	35.96109	23.17492	21.57665	22.37579	49.54638	20.77752	19.97838	52.74293	8.790488	12.78616	42.35417	58.88794

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	36.12761	29.33945	40.42532	35.23663	23.00908	24.22018	26.70844	26.804	31.67864	30.65782	24.81397	26.14621	25.92985	35.16736	36.20622
Indicator 2	39.96605	24.17949	50.00187	43.07406	22.21076	22.009	24.71217	20.87668	19.57125	34.41491	30.23684	28.12673	20.93727	43.85108	32.05972

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	33.48316	32.73511	41.64201	30.33362	21.85017	35.56778	14.21739	21.76453	22.86563	34.35431	43.83198	19.16233	21.95655	41.78206	40.62062
Indicator 2	34.28107	32.29432	35.52765	31.82685	25.63289	33.89151	17.41322	26.25618	27.15216	32.29432	37.16379	22.16583	26.25618	36.81319	35.13809
Indicator 3	29.88874	34.39932	29.49221	25.87384	25.42774	32.21838	17.59619	34.39932	23.59377	32.56535	41.88389	21.9085	26.96431	38.01769	40.14906
Indicator 4	26.64904	28.6299	44.76463	37.60887	18.35549	26.94377	16.58711	29.24678	22.29664	33.73626	41.88588	16.42261	16.3198	56.54011	39.56231

Period 2

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	30.77055	29.91581	41.0274	35.04424	32.48002	32.05266	7.692637	33.76213	10.25685	30.34318	37.60845	9.402112	15.38527	38.89056	37.18108
Indicator 2	16.9133	31.27801	52.45438	32.34378	34.89236	23.44692	10.33333	27.80268	26.08818	27.43197	40.54557	11.12107	17.84005	40.22121	29.10014
Indicator 3	17.68893	21.77099	40.82081	32.65649	32.65649	20.4103	12.24618	32.65649	23.13168	25.85305	38.09923	16.32824	20.4103	38.09923	48.98473
Indicator 4	25.94854	29.49037	32.95763	32.13742	26.91788	26.50778	25.24018	29.56493	25.613	30.2733	33.59143	17.44816	25.31474	31.13079	29.67678
Indicator 5	26.3948	29.68931	32.55746	32.98381	28.02267	26.93743	25.11576	28.60406	26.70487	30.07689	33.75899	17.71281	23.99175	30.23193	29.0304
Indicator 6	29.36734	26.65128	36.20598	29.22184	26.48153	29.34309	31.21037	24.881	23.35322	28.13056	30.55561	22.4317	27.11204	32.83516	24.03223

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	19.27064	27.83537	47.10601	38.54128	36.4001	19.27064	12.84709	36.4001	17.12946	29.97655	32.11774	14.98828	23.55301	38.54128	27.83537
Indicator 2	42.80686	21.53748	29.13369	42.9856	11.61773	48.52636	10.36659	21.44812	26.89951	41.10889	26.72078	19.0352	21.44812	30.11673	28.06129
Indicator 3	30.5907	24.34554	33.66036	44.03367	22.12269	29.63805	19.37058	25.08649	24.87479	23.18119	28.6854	15.24243	31.4375	36.51831	33.02525
Indicator 4	27.7706	28.21411	31.52339	29.40818	26.57654	29.13525	21.6638	29.74934	26.03068	28.72586	30.7046	23.94959	26.16714	31.28457	30.9093
Indicator 5	27.44107	29.21273	33.14976	35.23638	29.05525	26.69304	17.67725	26.77178	27.55918	28.50407	31.3781	22.44105	25.35445	31.69306	29.6458
Indicator 6	27.86003	28.87189	30.72698	30.79444	27.28664	28.56833	27.75884	27.35409	26.51087	25.26291	28.2985	29.54647	27.62392	28.33223	27.01681

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	23.7297	31.68613	45.36561	32.80283	19.33273	33.01221	14.69124	22.61301	20.51922	30.87651	36.5538	18.84418		41.80616	26.52143
Indicator 2	23.39674	16.624	56.64473	36.94222	14.65375	20.19508	32.07296	25.12071	23.15046	27.23559	27.64209	9.851258	21.21715	59.35383	23.39674
Indicator 3	31.37452	27.34065	36.10559	30.3785	22.41037	32.07173		31.37452	21.16535			15.73706	23.06684	35.15938	33.51595
Indicator 4	26.49034	30.5147	26.99169	23.33318	28.63125	27.87245		23.95648	25.50119			31.17866	30.94831	29.20035	30.2437

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembou	Netherland	Portugal	Spain	Sweden	UK
Indicator 1	22.48702	32.03796	38.08285	47.392	23.696	29.2573	28.77371	20.06906	20.67355	7.253877	29.3782	26.23486	28.41102	39.89632	28.16922
Indicator 2	23.27635	41.44326	32.35981	59.04246	9.651171	15.89605	1.703148	17.03148	11.35432	1.703148	18.16691	19.30234	14.1929	82.88653	73.80307

Chapter 7

Measuring systemic and institutional differences in human investment

In the preceding chapter a number of indicators were presented, providing an overall picture of human investment provision in the different countries. Using a combination of scorecards and radar diagrams, a comprehensive measurement of human investment, in accordance with the conceptual framework outlined in figure 1 of chapter 3 and the variables specified in table 1 of chapter 4, was provided. Hence, a number of indicators for the relevant education environments and stakeholders were presented for each period of the conceptual framework. However, from the sensitivity analysis of the composite indicators a number of potential problems associated with using the composite indicators from the radar-diagrams also emerged. Notably, the composite indicators for some countries and dimensions displayed quite significant sensitivity to the weights attached to sub-indicators. It was argued that a possible reason for this problem was the different priorities given to different features of human investment in different countries. This issue was also touched upon in chapter 4, where it was noted that the two periods of the framework are not merely made up of a number of individual parts, but constitute complex systems of human investment provision, and that these systems may differ between countries. This resulted in the specification of a number of systemic variables. Accordingly, each of the features measured in the scorecards of chapter 6 is mediated through an institutional framework of human investment provision. The nature of the institutional framework will determine the role played by each of the features in shaping overall human investment. For the purposes of benchmarking human investment in EU member states, and the policy instruments associated with the OMC and the Lisbon strategy, these considerations raise a pressing question: Can the role of each of the features measured in the scorecards be assumed to be similar in all member states?

It is the purpose of this chapter to facilitate an answer to this question. Accordingly, this chapter will provide some measurement of how the individual features operationalised in

the preceding chapters fit into a wider system of human investment provision in each member state, such as to ascertain which parts of the system provide the greatest benefits to human investment provision. This will allow policy makers to target their efforts in a more efficient manner.

In order to answer the question, the chapter will develop a set of indicators which measure the role of most of the features of period 1 in shaping human investment outcomes[1]. However, it is important to emphasise that the role of each feature is two-fold. Firstly, each feature can contribute directly in itself to human investment. Secondly, each feature can contribute through its interaction with other features of the human investment framework, and in so doing shape the role of other features. There may, in other words, be complementarities between features of the human investment framework. Each of these roles must be examined, and the analysis requires indicators measuring each of the manners in which a feature of human investment can contribute to human investment outcomes. Firstly, the chapter will aim to establish and develop indicators that capture the importance of the different indicators presented in the scorecards of chapter 6 for learning outcomes. Secondly, the analysis in this chapter will introduce a set of indicators which measure how the indicators presented in chapter 6 interact with each other.

The problems that such efforts are faced with are not all dissimilar to those faced by other efforts to operationalise multi-dimensional concepts and phenomena. A recent example of this problem is the measurement of ICT products, which are becoming increasingly diverse and multi-faceted. For example, how do you compare a computer with x amount of processing power and y memory to a computer with z processing power and q memory? One solution to this problem has been the introduction of hedonic measurements of products. This method disaggregates products into a number of facets and attempts to establish the relative importance of each feature in determining the overall price of the product. This is mainly done by means of regression analysis.

[1] Given the conceptual and methodological complexity of human investment provision in period 2, no satisfactory comparable measures are currently available for outcomes in period 2. Consequently, in what follows the analysis will be restricted to period 1.

Accordingly, the emergence of a more complex and diverse set of tangible products, has led statistical offices to recognise the need for more complex and sophisticated indicators. The arguments presented in chapters 3 and 4 of this project suggest that something similar may be required for human investment.

However, a particular problem when measuring human investment, is that the product in this case is not a tangible outcome, but rather the more complex and intangible learning outcomes. Accordingly, it is methodologically very difficult to apply the thinking applied to the measurement of multi-faceted tangible products to the measurement of human investment provision. Nevertheless, attempts have been made at establishing internationally comparable measures of education outcomes for period 1. Notably, the PISA data sets from OECD provide comparable measurements of learning outcomes in reading, mathematics and science. Using the PISA data set from the year 2000, this chapter will attempt to establish how important the different qualitative features of the human investment framework are in the different EU member states. This will allow for a more comprehensive comparison and benchmarking of period 1 of the conceptual framework of human investment provision in the European Union, which takes account of differences in the overall configuration of the framework of human investment provision. Indeed, it is only with the recent emergence of harmonised measures of education outcomes, with accompanying data on features of the formal and informal education environments, that the opportunity for the construction of comparable indicators of a sort not previously used in the benchmarking of human investment between countries has become possible.

7.1 Multi-variate multi-level regression analysis

The analysis in this chapter will adopt a method of regression analysis to examine the importance of the different qualitative features. However, given the hierarchical nature of the data, i.e. there will inevitably be interaction taking place between individuals in the same schools, the method will be a multivariate multi-level regression analysis. For example, the role of ICT in the home may depend on whether the student attends a school in which ICT is widely used. Using multi-level analysis will provide the opportunity to

establish how features of the informal education environment of the individual student interact differently in different formal educational environments. For this reason, multi-level regression analysis is a method increasingly used in the school efficiency literature to estimate the factors that contribute to education outcomes (Goldstein, 1995 and Hox, 1995). Accordingly, it is of interest to use this method to construct a set of more sophisticated indicators for comparison and benchmarking of human investment in the EU.

Conducting a separate analysis of each country will provide coefficients for each included variable for each member state. The coefficients constitute indicators measuring the importance of different student and school variables in each country. In addition, the introduction of interaction terms will allow for the construction of indicators of how ICT variables interact with other features of the system of human investment in period 1. Combined, the coefficients and interaction terms are indicators of how the features of the formal and informal education environments of period 1 are mediated through the institutional framework of human investment provision in a country and shape human investment outcomes.

The approach taken in this project will follow a basic two-level regression model, with the two levels of analysis being the individual and the school. This corresponds well with the two questionnaires of the OECD PISA study for the individual student and the school. The dependent variable in this two-level analysis will be the test score achieved by the student, i.e. at the student level. The explanatory variables, however, will be a combination of variables from the two levels of the analysis. The choice of explanatory variables will be decided by reference to other studies of school quality, while also include a number of variables for ICT.

The model used is formally outlined below:

$$zscore_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned} zscore_{ij} = {} & \beta_{0ij}cons + \beta_{1j}socecoind_{ij} + \beta_{2j}paredu_{ij} + \beta_{3j}icthome_{ij} + \beta_{4j}ictres_{ij} + \beta_{5j}teares_{ij} + \beta_6 half.socecoind_{ij} + \beta_7 half.paredu_{ij} + \\ & \beta_8 half.ictres_{ij} + \beta_9 half.teares_{ij} + \beta_{10} half.ictuse_{ij} + \beta_{11} full.socecoind_{ij} + \beta_{12} full.paredu_{ij} + \beta_{13} full.ictres_{ij} + \\ & \beta_{14} full.teares_{ij} + \beta_{15} full.ictuse_{ij} + \beta_{16} {>}2.5use.socecoind_{ij} + \beta_{17} {>}2.5use.paredu_{ij} + \beta_{18} {>}2.5use.icthome_{ij} + \\ & \beta_{19} {>}2.5use.ictres_{ij} + \beta_{20} {>}2.5use.teares_{ij} + \beta_{21} {>}socave.icthome_{ij} + \beta_{22} {>}socave.ictres_{ij} + \beta_{23} {>}socave.ictuse_{ij} + \\ & \beta_{24} ictuse_{ij} \end{aligned}$$

$$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$$

$$\beta_{1j} = \beta_1 + u_{1j}$$

$$\beta_{2j} = \beta_2 + u_{2j}$$

$$\beta_{3j} = \beta_3 + u_{3j}$$

$$\beta_{4j} = \beta_4 + u_{4j}$$

$$\beta_{5j} = \beta_5 + u_{5j}$$

$$\beta_{24j} = \beta_{24} + u_{24j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \\ u_{4j} \\ u_{5j} \\ u_{24j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} \sigma^2_{u0} & & & & & & \\ \sigma_{u10} & \sigma^2_{u1} & & & & & \\ \sigma_{u20} & \sigma_{u21} & \sigma^2_{u2} & & & & \\ \sigma_{u30} & \sigma_{u31} & \sigma_{u32} & \sigma^2_{u3} & & & \\ \sigma_{u40} & \sigma_{u41} & \sigma_{u42} & \sigma_{u43} & \sigma^2_{u4} & & \\ \sigma_{u50} & \sigma_{u51} & \sigma_{u52} & \sigma_{u53} & \sigma_{u54} & \sigma^2_{u5} & \\ \sigma_{u240} & \sigma_{u241} & \sigma_{u242} & \sigma_{u243} & \sigma_{u244} & \sigma_{u245} & \sigma^2_{u24} \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} \sigma^2_{e0} \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 3840.611(1591 of 1591 cases in use)

The model allows us to estimate the importance of a number of different variables. Below, each of the variables are specified, and a justification for their inclusion in the model outlined:

Outcome variable: z-value of test score ($zscore_{ij}$)
The outcome indicator is derived from the test score data in the student data set. Firstly, the average test score in the reading and mathematics tests is calculated. This is followed by a standardisation of the score by a calculation of the z-value from the average test score.

Explanatory variables:

Socio-economic index (socecoind$_{ij}$)
The socio-economic status of the household is a key determinant of resources available for the household. The indicator used is a socio-economic index developed by the OECD, and is thus a derived variable in the data set.

Parents education (paredu$_{ij}$)
Studies (Lee and Barro, 1998) have consistently shown a strong relationship between parent's level of education and the child's educational outcome. The ability and the likelihood of parents to get involved with their children's education is dependent on the parent's/guardian's own level of education. The indicator for parents' education level is calculated from the data on fathers and mothers level of education. The indicator is the highest level of education of either parent. Moreover, as was discussed in chapter 4, the role of parents' education may become more important as a result of the introduction of ICT as a learning tool in both the formal and informal education environments of period 1.

ICT in the home (icthome$_{ij}$)
The role of ICT for educational purposes is not limited to the school, but may prove an equally important educational resource in the home. Furthermore, the availability of ICT in the home is likely to have an impact on the use of ICT in the school and vice versa. The indicator measuring ICT in the home is derived from the two variables on the availability of internet and computers in the home. If both internet and computers are available in the home, the indicator is given a value of 2. If only one of either internet or computer is available in the home the indicator is given a value of 1. If neither internet nor computers are available in the home, the indicator is given a value of 0.

Teacher resources (tearesj)

It is widely argued that the teaching quality is closely linked to the number of teachers that are available to teach the students. Studies (Lee and Barro, 1998) have shown that the ratio of students to each teacher in the school can be significant in determining educational outcomes. The ratio of students to teacher may also have significant implications for the use of new educational technologies and pedagogical practices. Furthermore, much as the quantity of teachers may be of importance to educational outcomes, so the quality can be a determining factor of education outcomes. It is likely that teachers of higher quality have different educational practices than lower quality teachers, and will have a better grasp of the subject matter. With regard to the educational changes brought about by the New Economy more qualified teachers are likely to be more able and willing to make use of new educational technologies. The indicator of teacher resources is a composite index of variables measuring the student/teacher ratio and the proportion of teachers qualified to ISCED level 5 or fully certified. The indicator is constructed by applying the following equation:

Teacher resources = 100 * ((teacher/student ratio * prop. qual.) + (0.5 *(teacher/student ratio * (1 – prop. qual.))))

This provides an index of teacher resources adjusted by the qualifications of the teachers.

ICT resources (ictresij)

The availability of ICT resources is critical for the reshaping of education. In order to exploit the new educational technologies, there must be sufficient ICT resources available. In addition, to make full use of the information available from the internet and electronic networks, schools must provide access to these networks through their ICT resources. The indicator measuring ICT resources in the school is derived from variables measuring the computer/student ratio and the proportion of computers with internet access. The indicator is constructed by applying the following equation:

ICTres = 100 * ((computer/student ratio * prop. comp. w. internet) + (0.5 * (computer/student ratio * (1 –prop. comp. w. internet))))

ICT use ($ictuse_{ij}$)
The availability of ICT does not ensure its utilisation. Hence, a separate variable is included, estimating the use of computers and internet by students in school. The indicator measuring students use of ICT in schools is constructed as the average of two indicators measuring the frequency of use of computers and internet respectively.

7.1.1 Interaction terms

In light of the discussion in chapter 4 of the role of ICT for learning opportunities in period 1, it is important to establish how ICT affects the role of the other factors shaping education outcomes. Hence, it was argued in chapter 4 that the introduction of ICT as a learning technology may further exacerbate inequalities based on e.g. socio-economic status or teacher resources, rather than decrease the effects of such inequalities. The impact of ICT will undoubtedly depend on the existing institutional framework of education and the make up of the existing social fabric in which the technology is introduced. The introduction of ICT thus introduces a number of new complex relationships in human investment provision, which a satisfactory operationalisation should ideally take account of. Accordingly, a number of interaction terms are introduced in the model, measuring the interaction between the various ICT variables and other explanatory variables, but also the interaction between the ICT variables. The interaction terms have been developed in the following way:

The variable ICThome is a categorical variable where 0=no ICT equipment 1=half=either computer or internet available in the home, but not both, and 2=full=both computer and internet available in the home. To gauge the interaction of this variable with other explanatory variables, the categorical values of 1 and 2 are set together with each of the other explanatory variables. The coefficient on the interaction terms with 'half' and another explanatory variable shows how much the coefficient of the other explanatory variable is altered as a result of households having either computer or internet in the household, compared to having neither. Similarly, the interaction term 'full' and another explanatory variable shows how the coefficient of the latter is altered for households with

both computer and internet compared to households having neither. Accordingly, the coefficients on the explanatory variables themselves are estimated for the population with neither computer nor internet at home.

The second categorical interaction term refers to ICT use in the school. There are two values for this categorical variable: If the ICTuse value is > or equal to 2.5 the value of the interaction term is 1. If the ICTuse value is less than 2.5 the value of the categorical variable is 0. Accordingly, the interaction terms with ICTuse and another explanatory variable shows how the coefficient of the latter is altered for students with ICTuse value greater or equal to 2.5, compared to students with an ICTuse value of less than 2.5.

In addition, a third categorical variable is introduced as an interaction term. The interaction terms with '>socave' measure the change in the coefficients of the explanatory variables for pupils from homes with a socio-economic index value greater than the mean, compared to those from households with a socio-economic index lower than the mean.

The introduction of interaction terms allows us to ascertain how ICT in the formal and informal education environments interact with other explanatory variables, and how ICT as an educational resource in the two educational environments interact with each other. The sign, value and significance of these interaction terms are relevant as indicators of the role of ICT in human investment provision in period 1. Indeed, the role of ICT as an interaction term with traditional features of human investment provision may be more suitable proxies of how ICT is utilised for human investment provision, than the measurement of ICT resources itself.

7.1.2 Two-level model

In contrast to traditional regression analysis, the model developed for the analysis in this chapter is in two levels. This allows us to estimate how much the intercept and the explanatory variables vary between and within schools. In the model the inter- and intra-school effects are captured in the error terms uij and eij. The error term uij measures how

much of the variance in the z-scores is explained at the school level, while the error term eij measures the variance in the z-scores explained at the student level. Hence the value of u0j indicates how much the school's values of the intercept depart from the average intercept. The value of e0ij indicates how much the ith student in the jth school departs from its school's line. uij and eij are thus the school level and student level residuals respectively. The proportion of the total variance made up by the school level variance (i.e. uij/(uij + eij)) is also known as the intra-school correlation, and measures the extent to which the scores of the students in the same school resemble each other compared to the scores of students in other schools. The school-level variance matrix also consists of covariances (σuxy) between the intercept and the various explanatory variables. These measure the way in which the value of the explanatory variables and the intercept relate to each other. Hence if the covariance between the intercept and socio-economic variable is positive, the schools with higher intercepts tend to have higher coefficients on the socio-economic variable. These measurements are themselves important as indicators of human investment, as they highlight the way in which characteristics of the informal education environment of students and the formal education environment interact with each other. However, it should be noted that the covariances often are statistically insignificant.

Overall, the model allows for an estimation of the significance of features in the formal and informal education environment of period 1, and illuminates a number of the more complex features emerging from the conceptual framework developed in chapter 3 and variables discussed and specified in chapter 4. Moreover, the model allows for an estimation of the interaction between the features of the formal and informal education environments, and between features within these education environments. These interactions are captured in the interaction terms in the model. They show how the availability and use of ICT in the two environments interact with each other, and how these new learning technologies interact with other features of the education environments which have traditionally played significant roles in shaping learning outcomes. The inclusion of these traditional features of both the formal and informal education environments also allows us to arrive at a more controlled measure of the

significance of the new qualitative features emerging with the technologies of the New Economy. Furthermore, by including two levels in the model, it is possible to ascertain how much of the variation in performance is within schools and between schools. In other words, how much of the variation is at the level of the individual student and how much of the variation is explained at the level of the school.

7.1.3 Data

The data for the analysis outlined above is taken from the OECD PISA study. The data was collected during the year 2000. The PISA study has collected data from surveys of schools and individual students at the age of 15. This allows for an econometric analysis of human investment outcomes during period 1 in the different EU countries. Moreover, the data set is particularly useful for the purposes of this project, because it covers all member states and is very rich in data on the availability and use of ICT.

After cleaning the data for missing values, sufficient data was available for all countries to conduct an analysis. However, for some countries, notably France, the number of cases is less than desirable. This is mainly due to missing school level data for France. Accordingly, when merging school level and student level data files, a lot of cases were lost. A similar problem also occurred with the Finnish data, but the loss of cases was less severe. Nevertheless, the fact that a relatively large number of cases had to be neglected for some of the countries represents a weakness, which will have to be kept in mind when interpreting the results.

7.1.4 Results

The results from the econometric analysis are presented in ANNEX 1 of this chapter. For each country there is an equation, with the estimations for each of the coefficients and interaction terms. Each of these estimations constitutes indicators of relevance for the operationalisation of human investment. These results will be analysed further in the next chapter.

7.2 Conclusion

The objective of this chapter has been to take the operationalisation of human investment further, such as to account for the complex matrix of human investment provision emerging with the new paradigm of lifelong learning. Chapter 6 developed indicators showing the relative performance of countries in different dimensions of the human investment framework. This chapter has developed indicators measuring the importance of different dimensions of human investment provision for learning outcomes. Furthermore, the chapter has developed indicators showing how the role of ICT for human investment purposes is not merely as an additional tool for human investment provision, but that the whole framework of human investment provision is changed as a result of its introduction. A satisfactory comparison and benchmarking of human investment provision needs to take account of such complex processes of human investment within the European Union. In this chapter it has thus been shown how statistical analysis of available data can provide indicators that allow us to estimate the more complex transformations of human investment provision resulting from the introduction of ICT. This chapter has thus argued that the complex transformation of human investment provision may require us to develop more sophisticated indicators for the satisfactory operationalisation of human investment. Indeed, the chapter outlines and conduct an analysis that can provide us with the necessary indicators for period 1 of the human investment framework.

It may seem a complex and arduous process to go through to arrive at a set of indicators that can say something more about the qualitative changes to human investment provision. However, it is worth remembering that similar complex methods are already being adopted for the development of satisfactory indicators of tangible products. The construction of hedonic measurements of ICT is thus also very complex. The emergence of the New Economy brings with it the methodological challenge of measuring and comparing a diverse range of multi-faceted products. In particular, it is becoming increasingly important to be able to measure and compare products that are subject to continuous qualitative change. More sophisticated methods are required to meet this challenge, and the attempts in this chapter only take the first tentative steps.

The methodology and approach developed in this chapter thus has a number of possible implications for the production and use of human investment indicators. In particular, the analysis has highlighted the importance of taking account of qualitative changes in the overall system of human investment provision, and presented a possible method of developing indicators for these changes. Furthermore, as human investment becomes more diverse and complex, and takes place in a number of different educational environments, it is important to take account of the developments that take place in all of these environments, and how the relationship between the environments and variables are transformed. Again, the approach developed in this chapter has attempted to deal with these issues. As further changes are taking place in the provision of education and training, and data on these developments are produced from surveys, it is hoped that the basic approach developed in this project can provide a framework for constructing nationally comparable indicators of the complex processes of human investment.

In the chapters that follow, the indicators that have been developed and presented in chapters 6 and 7 will be further analysed and discussed. The emphasis will particularly be on how the indicators developed in the two chapters illuminate aspects of human investment left uncovered by previously used indicators of human investment. This will be followed by a discussion of the implications arising from the analysis conducted in this project.

ANNEX 1

Austria

$$\text{zscore}_{ij} \sim N(\chi B,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + \beta_{4j}\text{ictres}_{j} + \beta_{5j}\text{teares}_{j} + 0.001(0.006)\text{half.socecoind}_{ij} + \\ & -0.030(0.062)\text{half.paredu}_{ij} + -0.006(0.008)\text{half.ictres}_{ij} + -0.002(0.015)\text{half.teares}_{ij} + 0.006(0.056)\text{half.ictuse}_{ij} + \\ & -0.004(0.007)\text{full.socecoind}_{ij} + -0.059(0.068)\text{full.paredu}_{ij} + -0.002(0.009)\text{full.ictres}_{ij} + 0.009(0.016)\text{full.teares}_{ij} + \\ & -0.010(0.078)\text{full.ictuse}_{ij} + -0.003(0.004)\text{>2.5use.socecoind}_{ij} + 0.039(0.043)\text{>2.5use.paredu}_{ij} + \\ & -0.146(0.117)\text{>2.5use.icthome}_{ij} + 0.015(0.006)\text{>2.5use.ictres}_{ij} + -0.006(0.013)\text{>2.5use.teares}_{ij} + \\ & 0.138(0.079)\text{>socave.icthome}_{ij} + 0.000(0.005)\text{>socave.ictres}_{ij} + -0.050(0.032)\text{>socave.ictuse}_{ij} + \beta_{24}\text{ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = -1.021(0.266) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.007(0.005) + u_{1j}$$

$$\beta_{2j} = 0.046(0.066) + u_{2j}$$

$$\beta_{3j} = 0.386(0.157) + u_{3j}$$

$$\beta_{4j} = 0.004(0.010) + u_{4j}$$

$$\beta_{5j} = -0.016(0.016) + u_{5j}$$

$$\beta_{24} = 0.059(0.058) + u_{24j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \\ u_{4j} \\ u_{5j} \\ u_{24j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.586(0.153) & & & & & & \\ 0.000(0.000) & 0.000(0.000) & & & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & & & \\ -0.018(0.008) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.001(0.000) & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & \\ 0.018(0.019) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.001) & 0.000(0.000) & 0.001(0.004) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.538(0.021) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 3840.611(1591 of 1591 cases in use)

Belgium

$z\,score_{ij} \sim N(XB,\ \Omega)$

$z\,score_{ij} = \beta_{0ij}cons + \beta_{1j}socecoind1_{ij} + \beta_{2j}paredu2_{ij} + -0.141(0.020)teares1_{j} + 0.008(0.010)ictres1_{j} + 0.114(0.044)ictuse_{ij} +$
$0.452(0.127)icthome1_{ij} + 0.003(0.011)\text{>2.5use.teares1}_{ij} + -0.013(0.023)\text{>2.5use.paredu2}_{ij} +$
$0.115(0.066)\text{>2.5use.icthome1}_{ij} + -0.010(0.006)\text{>2.5use.ictres1}_{ij} + 0.013(0.029)\text{half.paredu2\#1}_{ij} +$
$-0.004(0.007)\text{half.ictres1\#1}_{ij} + -0.075(0.039)\text{half.ictuse}_{ij} + -0.029(0.036)\text{full.paredu2\#1}_{ij} +$
$-0.002(0.007)\text{full.ictres1\#1}_{ij} + -0.101(0.054)\text{full.ictuse}_{ij} + -0.002(0.002)\text{>2.5use.socecoind1}_{ij} +$
$-0.017(0.014)\text{half.teares1\#2}_{ij} + 0.000(0.003)\text{half.socecoind1\#2}_{ij} + -0.038(0.016)\text{full.teares1\#2}_{ij} +$
$0.000(0.003)\text{full.socecoind1\#2}_{ij} + -0.027(0.032)\text{>socave.icthome1}_{ij} + 0.004(0.004)\text{>socave.ictres1}_{ij} +$
$-0.005(0.018)\text{>socave.ictuse}_{ij}$

$\beta_{0j} = -0.117(0.217) + u_{0j} + e_{0ij}$

$\beta_{1j} = 0.008(0.003) + u_{1j}$

$\beta_{2j} = 0.027(0.029) + u_{2j}$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \end{bmatrix} \sim N(0,\ \Omega_u) : \Omega_u = \begin{bmatrix} 0.255(0.112) & & \\ 0.000(0.001) & 0.000(0.000) & \\ 0.001(0.017) & 0.000(0.000) & 0.006(0.004) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) : \Omega_e = \begin{bmatrix} 0.476(0.014) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 6498.162(2882 of 2882 cases in use)

Denmark

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + 0.011(0.023)\text{ictres}_{j} + \text{-}0.026(0.051)\text{teares}_{j} + \\ & 0.202(0.101)\text{ictuse}_{ij} + 0.002(0.009)\text{half.socecoind}_{ij} + 0.195(0.078)\text{half.paredu}_{ij} + \text{-}0.014(0.010)\text{half.ictres}_{ij} + \\ & 0.039(0.035)\text{half.teares}_{ij} + \text{-}0.240(0.095)\text{half.ictuse}_{ij} + 0.008(0.010)\text{full.socecoind}_{ij} + 0.128(0.082)\text{full.paredu}_{ij} + \\ & \text{-}0.013(0.010)\text{full.ictres}_{ij} + 0.014(0.038)\text{full.teares}_{ij} + \text{-}0.215(0.115)\text{full.ictuse}_{ij} + 0.003(0.007)\text{>2.5use.socecoind}_{ij} + \\ & 0.007(0.079)\text{>2.5use.paredu}_{ij} + 0.000(0.021)\text{>2.5use.ictres}_{ij} + \text{-}0.010(0.040)\text{>2.5use.teares}_{ij} + \\ & 0.031(0.198)\text{>2.5use.icthome}_{ij} + 0.001(0.002)\text{>socave.ictres}_{ij} + 0.049(0.047)\text{>socave.ictuse}_{ij} + \\ & \text{-}0.086(0.120)\text{>socave.icthome}_{ij}\end{aligned}$$

$$\beta_{0j} = \text{-}1.587(0.509) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = \text{-}0.003(0.010) + u_{1j}$$

$$\beta_{2j} = 0.057(0.103) + u_{2j}$$

$$\beta_{3j} = 0.261(0.300) + u_{3j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.622(0.306) & & & \\ 0.000(0.003) & 0.000(0.000) & & \\ \text{-}0.049(0.045) & 0.000(0.000) & 0.000(0.008) & \\ \text{-}0.186(0.072) & 0.000(0.001) & 0.033(0.011) & 0.011(0.027) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.802(0.034) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 3999.575(1501 of 1501 cases in use)

Finland

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + \beta_{4j}\text{ictres}_{ij} + \beta_{5j}\text{teares}_{ij} + 0.002(0.078)\text{ictuse}_{ij} + \\ & 0.002(0.006)\text{half.socecoind}_{ij} + 0.044(0.058)\text{half.paredu}_{ij} + 0.013(0.016)\text{half.ictres}_{ij} + 0.033(0.042)\text{half.teares}_{ij} + \\ & -0.081(0.074)\text{half.ictuse}_{ij} + 0.004(0.008)\text{full.socecoind}_{ij} + 0.044(0.057)\text{full.paredu}_{ij} + 0.015(0.016)\text{full.ictres}_{ij} + \\ & 0.022(0.052)\text{full.teares}_{ij} + -0.011(0.099)\text{full.ictuse}_{ij} + 0.001(0.005)\text{>2.5use.socecoind}_{ij} + \\ & -0.043(0.047)\text{>2.5use.paredu}_{ij} + 0.067(0.140)\text{>2.5use.icthome}_{ij} + -0.013(0.016)\text{>2.5use.ictres}_{ij} + \\ & 0.019(0.032)\text{>2.5use.teares}_{ij} + 0.003(0.104)\text{>socave.icthome}_{ij} + 0.015(0.008)\text{>socave.ictres}_{ij} + \\ & -0.032(0.047)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = -0.190(0.457) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.000(0.006) + u_{1j}$$

$$\beta_{2j} = 0.092(0.060) + u_{2j}$$

$$\beta_{3j} = -0.220(0.267) + u_{3j}$$

$$\beta_{4j} = -0.013(0.020) + u_{4j}$$

$$\beta_{5j} = -0.037(0.047) + u_{5j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \\ u_{4j} \\ u_{5j} \end{bmatrix} \sim N(0,\ \Omega_u) : \Omega_u = \begin{bmatrix} 0.000(0.000) & & & & & \\ 0.000(0.000) & 0.000(0.000) & & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.035(0.015) & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & -0.003(0.001) & 0.000(0.000) & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) : \Omega_e = \begin{bmatrix} 0.864(0.033) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 4049.358(1483 of 1499 cases in use)

France

$$zscore_{ij} \sim N(XB, \Omega)$$

$$\begin{aligned} zscore_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + -0.020(0.020)\text{ictres}_{j} + -0.004(0.030)\text{teares}_{j} + \\ & 0.207(0.119)\text{ictuse}_{ij} + 0.009(0.008)\text{half.socecoind}_{ij} + -0.020(0.070)\text{half.paredu}_{ij} + 0.008(0.022)\text{half.ictres}_{ij} + \\ & 0.025(0.031)\text{half.teares}_{ij} + -0.249(0.121)\text{half.ictuse}_{ij} + 0.010(0.010)\text{full.socecoind}_{ij} + 0.030(0.092)\text{full.paredu}_{ij} + \\ & -0.003(0.024)\text{full.ictres}_{ij} + -0.004(0.035)\text{full.teares}_{j} + -0.271(0.185)\text{full.ictuse}_{ij} + -0.006(0.006)\text{>2.5use.socecoind}_{ij} + \\ & 0.038(0.061)\text{>2.5use.paredu}_{ij} + 0.193(0.226)\text{>2.5use.icthome}_{ij} + 0.003(0.019)\text{>2.5use.ictres}_{ij} + \\ & -0.019(0.025)\text{>2.5use.teares}_{ij} + -0.051(0.135)\text{>socave.icthome}_{ij} + 0.015(0.014)\text{>socave.ictres}_{ij} + \\ & 0.049(0.086)\text{>socave.ictuse}_{ij} \end{aligned}$$

$$\beta_{0j} = -0.608(0.445) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = -0.007(0.007) + u_{1j}$$

$$\beta_{2j} = 0.058(0.066) + u_{2j}$$

$$\beta_{3j} = 0.247(0.313) + u_{3j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.195(0.137) & & & \\ -0.003(0.002) & 0.000(0.000) & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.871(0.048) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 2026.674(745 of 745 cases in use)

Germany

$$zscore_{ij} \sim N(XB, \Omega)$$

$$\begin{aligned} zscore_{ij} = {} & \beta_{0ij}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{icthome}_{ij} + -0.040(0.030)\text{ictres}_{j} + 0.040(0.048)\text{teares}_{j} + -0.063(0.066)\text{ictuse}_{ij} + \\ & -0.002(0.004)\text{half.socecoind}_{ij} + 0.011(0.044)\text{half.paredu}_{ij} + -0.006(0.024)\text{half.ictres}_{ij} + 0.017(0.033)\text{half.teares}_{ij} + \\ & 0.028(0.062)\text{half.ictuse}_{ij} + -0.001(0.005)\text{full.socecoind}_{ij} + 0.018(0.051)\text{full.paredu}_{ij} + -0.014(0.025)\text{full.ictres}_{ij} + \\ & -0.012(0.040)\text{full.teares}_{j} + 0.026(0.086)\text{full.ictuse}_{ij} + 0.002(0.003)\text{>2.5use.socecoind}_{ij} + \\ & 0.000(0.029)\text{>2.5use.paredu}_{ij} + 0.002(0.097)\text{>2.5use.icthome}_{ij} + 0.015(0.017)\text{>2.5use.ictres}_{ij} + \\ & -0.013(0.022)\text{>2.5use.teares}_{ij} + 0.080(0.063)\text{>socave.icthome}_{ij} + -0.017(0.014)\text{>socave.ictres}_{ij} + \\ & -0.014(0.038)\text{>socave.ictuse}_{ij} + 0.095(0.043)\text{paredu}_{ij} \end{aligned}$$

$$\beta_{0ij} = -0.860(0.327) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.004(0.004) + u_{1j}$$

$$\beta_{2j} = 0.059(0.169) + u_{2j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.426(0.050) & & \\ 0.000(0.000) & 0.000(0.000) & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.451(0.015) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 4483.264(1986 of 1986 cases in use)

Greece

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0ij}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + \beta_{4j}\text{ictres}_{j} + \beta_{5j}\text{teares}_{j} + 0.001(0.006)\text{half.socecoind}_{ij} + \\ & -0.030(0.062)\text{half.paredu}_{ij} + -0.006(0.008)\text{half.ictres}_{ij} + -0.002(0.015)\text{half.teares}_{ij} + 0.006(0.056)\text{half.ictuse}_{ij} + \\ & -0.004(0.007)\text{full.socecoind}_{ij} + -0.059(0.068)\text{full.paredu}_{ij} + -0.002(0.009)\text{full.ictres}_{ij} + 0.009(0.016)\text{full.teares}_{ij} + \\ & -0.010(0.078)\text{full.ictuse}_{ij} + -0.003(0.004)\text{>2.5use.socecoind}_{ij} + 0.039(0.043)\text{>2.5use.paredu}_{ij} + \\ & -0.146(0.117)\text{>2.5use.icthome}_{ij} + 0.015(0.006)\text{>2.5use.ictres}_{ij} + -0.006(0.013)\text{>2.5use.teares}_{ij} + \\ & 0.138(0.079)\text{>socave.icthome}_{ij} + 0.000(0.005)\text{>socave.ictres}_{ij} + -0.050(0.032)\text{>socave.ictuse}_{ij} + \beta_{24}\text{ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = -1.021(0.266) + u_{0j} + e_{0ij}$$
$$\beta_{1j} = 0.007(0.005) + u_{1j}$$
$$\beta_{2j} = 0.046(0.066) + u_{2j}$$
$$\beta_{3j} = 0.386(0.157) + u_{3j}$$
$$\beta_{4j} = 0.004(0.010) + u_{4j}$$
$$\beta_{5j} = -0.016(0.016) + u_{5j}$$
$$\beta_{24} = 0.059(0.058) + u_{24j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \\ u_{4j} \\ u_{5j} \\ u_{24j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.586(0.153) & & & & & & \\ 0.000(0.000) & 0.000(0.000) & & & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & & & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & & & \\ -0.018(0.008) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.001(0.000) & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & \\ 0.018(0.019) & 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & 0.000(0.001) & 0.000(0.000) & 0.001(0.004) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.538(0.021) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 3840.611(1591 of 1591 cases in use)

Ireland

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0ij}\text{cons} + \beta_{1ij}\text{socecoind}_{ij} + \beta_{2ij}\text{paredu}_{ij} + -0.045(0.015)\text{ictres}_{ij} + \beta_{4ij}\text{teares}_{ij} + 0.051(0.060)\text{ictuse}_{ij} + \\ & 0.003(0.005)\text{half.socecoind}_{ij} + 0.027(0.037)\text{half.paredu}_{ij} + 0.026(0.017)\text{half.ictres}_{ij} + -0.073(0.058)\text{half.ictuse}_{ij} + \\ & -0.011(0.038)\text{half.teares}_{ij} + 0.009(0.006)\text{full.socecoind}_{ij} + 0.076(0.038)\text{full.paredu}_{ij} + 0.017(0.016)\text{full.ictres}_{ij} + \\ & -0.026(0.082)\text{full.ictuse}_{ij} + -0.059(0.039)\text{full.teares}_{ij} + -0.002(0.004)\text{>2.5use.socecoind}_{ij} + \\ & -0.046(0.031)\text{>2.5use.paredu}_{ij} + 0.018(0.103)\text{>2.5use.icthome}_{ij} + 0.015(0.014)\text{>2.5use.ictres}_{ij} + \\ & 0.046(0.034)\text{>2.5use.teares}_{ij} + -0.042(0.082)\text{>socave.icthome}_{ij} + 0.018(0.012)\text{>socave.ictres}_{ij} + \\ & 0.017(0.043)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0ij} = -0.187(0.326) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.002(0.004) + u_{1j}$$

$$\beta_{2j} = 0.044(0.030) + u_{2j}$$

$$\beta_{4j} = -0.045(0.053) + u_{4j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{4j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 2.082(1.054) & & & \\ 0.000(0.000) & 0.000(0.000) & & \\ 0.000(0.000) & 0.000(0.000) & 0.000(0.000) & \\ -0.315(0.158) & 0.000(0.000) & 0.000(0.000) & 0.048(0.024) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.823(0.028) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 5030.947(1870 of 1870 cases in use)

Italy

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0ij}\text{cons} + 0.003(0.004)\text{socecoind}_{ij} + 0.002(0.036)\text{paredu}_{ij} + -0.019(0.167)\text{icthome}_{ij} + \beta_{4j}\text{ictres}_{j} + \beta_{5j}\text{teares}_{j} + \\ & 0.066(0.060)\text{ictuse}_{ij} + -0.003(0.004)\text{half.socecoind}_{ij} + 0.019(0.038)\text{half.paredu}_{ij} + 0.006(0.013)\text{half.ictres}_{ij} + \\ & 0.040(0.029)\text{half.teares}_{ij} + -0.081(0.057)\text{half.ictuse}_{ij} + -0.001(0.005)\text{full.socecoind}_{ij} + 0.028(0.047)\text{full.paredu}_{ij} + \\ & -0.012(0.015)\text{full.ictres}_{ij} + 0.067(0.038)\text{full.teares}_{ij} + -0.158(0.079)\text{full.ictuse}_{ij} + 0.001(0.003)\text{>2.5use.socecoind}_{ij} + \\ & -0.014(0.034)\text{>2.5use.paredu}_{ij} + 0.116(0.089)\text{>2.5use.icthome}_{ij} + 0.022(0.014)\text{>2.5use.ictres}_{ij} + \\ & -0.018(0.026)\text{>2.5use.teares}_{ij} + -0.011(0.066)\text{>socave.icthome}_{ij} + 0.011(0.010)\text{>socave.ictres}_{ij} + \\ & 0.004(0.036)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0ij} = 1.038(0.345) + u_{0j} + e_{0ij}$$

$$\beta_{4j} = 0.010(0.023) + u_{4j}$$

$$\beta_{5j} = -0.255(0.059) + u_{5j}$$

$$\begin{bmatrix} u_{0j} \\ u_{4j} \\ u_{5j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 1.154(0.876) & & \\ 0.066(0.057) & 0.001(0.003) & \\ -0.216(0.172) & -0.011(0.010) & 0.048(0.034) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.531(0.018) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = **4294.723(1822 of 1822 cases in use)**

Luxembourg

$$zscore_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned} zscore_{ij} = {} & \beta_{0j}\text{cons} + 0.025(0.008)\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + 0.139(0.282)\text{icthome}_{ij} + 0.127(0.057)\text{ictres}_{j} + \\ & -0.132(0.071)\text{teares}_{j} + 0.128(0.083)\text{ictuse}_{ij} + -0.003(0.007)\text{half.socecoind}_{ij} + 0.049(0.058)\text{half.paredu}_{ij} + \\ & -0.046(0.059)\text{half.ictres}_{ij} + 0.059(0.072)\text{half.teares}_{ij} + -0.120(0.080)\text{half.ictuse}_{ij} + -0.005(0.009)\text{full.socecoind}_{ij} + \\ & -0.010(0.058)\text{full.paredu}_{ij} + -0.066(0.055)\text{full.ictres}_{ij} + 0.116(0.074)\text{full.teares}_{ij} + -0.200(0.109)\text{full.ictuse}_{ij} + \\ & -0.004(0.005)\text{>2.5use.socecoind}_{ij} + -0.060(0.044)\text{>2.5use.paredu}_{ij} + 0.324(0.149)\text{>2.5use.icthome}_{ij} + \\ & -0.010(0.030)\text{>2.5use.ictres}_{ij} + 0.017(0.038)\text{>2.5use.teares}_{ij} + 0.207(0.129)\text{>socave.icthome}_{ij} + \\ & -0.048(0.018)\text{>socave.ictres}_{ij} + 0.045(0.054)\text{>socave.ictuse}_{ij} \end{aligned}$$

$$\beta_{0j} = -1.786(0.457) + u_{0j} + e_{0ij}$$

$$\beta_{2j} = 0.085(0.055) + u_{2j}$$

$$\begin{bmatrix} u_{0j} \\ u_{2j} \end{bmatrix} \sim N(0,\ \Omega_u) : \Omega_u = \begin{bmatrix} 0.000(0.000) & \\ 0.000(0.000) & 0.000(0.000) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) : \Omega_e = \begin{bmatrix} 0.803(0.035) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 2819.875(1077 of 1077 cases in use)

Netherlands

$$zscore_{ij} \sim N(XB, \Omega)$$

$$\begin{aligned} zscore_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + -0.388(0.236)\text{icthome}_{ij} + 0.018(0.039)\text{ictres}_{ij} + -0.311(0.106)\text{teares}_{ij} + \\ & -0.282(0.161)\text{ictuse}_{ij} + -0.009(0.010)\text{half.socecoind}_{ij} + -0.005(0.097)\text{half.paredu}_{ij} + -0.040(0.035)\text{half.ictres}_{ij} + \\ & 0.116(0.080)\text{half.teares}_{ij} + 0.359(0.155)\text{half.ictuse}_{ij} + -0.007(0.011)\text{full.socecoind}_{ij} + 0.012(0.100)\text{full.paredu}_{ij} + \\ & -0.028(0.035)\text{full.ictres}_{ij} + 0.202(0.087)\text{full.teares}_{ij} + 0.345(0.173)\text{full.ictuse}_{ij} + 0.001(0.005)\text{>2.5use.socecoind}_{ij} + \\ & -0.009(0.040)\text{>2.5use.paredu}_{ij} + -0.013(0.144)\text{>2.5use.icthome}_{ij} + -0.001(0.013)\text{>2.5use.ictres}_{ij} + \\ & 0.024(0.039)\text{>2.5use.teares}_{ij} + -0.127(0.108)\text{>socave.icthome}_{ij} + 0.008(0.012)\text{>socave.ictres}_{ij} + \\ & 0.022(0.049)\text{>socave.ictuse}_{ij} \end{aligned}$$

$$\beta_{0j} = 0.648(0.469) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.013(0.010) + u_{1j}$$

$$\beta_{2j} = 0.027(0.097) + u_{2j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.537(0.192) & & \\ -0.001(0.002) & 0.000(0.000) & \\ -0.008(0.025) & -0.001(0.000) & 0.006(0.006) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.420(0.024) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 1761.159(800 of 800 cases in use)

Portugal

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + \beta_{3j}\text{icthome}_{ij} + 0.002(0.003)\text{ictres}_{j} + 0.000(0.001)\text{teares}_{j} + \beta_{6j}\text{ictuse}_{ij} + \\ & 0.001(0.004)\text{half.socecoind}_{ij} + 0.018(0.033)\text{half.paredu}_{ij} + -0.001(0.002)\text{half.ictres}_{ij} + 0.000(0.001)\text{half.teares}_{ij} + \\ & 0.004(0.047)\text{half.ictuse}_{ij} + -0.005(0.005)\text{full.socecoind}_{ij} + 0.105(0.040)\text{full.paredu}_{ij} + 0.000(0.003)\text{full.ictres}_{ij} + \\ & 0.001(0.001)\text{full.teares}_{ij} + -0.065(0.073)\text{full.ictuse}_{ij} + -0.001(0.003)\text{>2.5use.socecoind}_{ij} + \\ & -0.031(0.029)\text{>2.5use.paredu}_{ij} + 0.121(0.102)\text{>2.5use.icthome}_{ij} + -0.003(0.002)\text{>2.5use.ictres}_{ij} + \\ & 0.000(0.001)\text{>2.5use.teares}_{ij} + 0.124(0.077)\text{>socave.icthome}_{ij} + 0.001(0.002)\text{>socave.ictres}_{ij} + \\ & -0.045(0.032)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = -0.843(0.145) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.013(0.004) + u_{1j}$$

$$\beta_{2j} = -0.027(0.026) + u_{2j}$$

$$\beta_{3j} = 0.074(0.106) + u_{3j}$$

$$\beta_{6j} = 0.097(0.038) + u_{6j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \\ u_{6j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.212(0.104) & & & & \\ -0.002(0.002) & 0.000(0.000) & & & \\ 0.022(0.014) & 0.000(0.000) & 0.002(0.004) & & \\ -0.034(0.026) & 0.000(0.001) & -0.004(0.005) & 0.011(0.013) & \\ -0.020(0.017) & 0.000(0.000) & -0.002(0.003) & 0.000(0.006) & 0.008(0.005) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.599(0.023) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 4507.360(1827 of 1827 cases in use)

Spain

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + \beta_{2j}\text{paredu}_{ij} + 0.231(0.149)\text{icthome}_{ij} + -0.006(0.017)\text{ictres}_{j} + -0.127(0.037)\text{teares}_{j} + \\ & 0.244(0.053)\text{ictuse}_{ij} + 0.002(0.004)\text{half.socecoind}_{ij} + -0.009(0.029)\text{half.paredu}_{ij} + 0.006(0.017)\text{half.ictres}_{ij} + \\ & 0.026(0.033)\text{half.teares}_{ij} + -0.152(0.053)\text{half.ictuse}_{ij} + 0.004(0.005)\text{full.socecoind}_{ij} + 0.023(0.037)\text{full.paredu}_{ij} + \\ & 0.006(0.020)\text{full.ictres}_{ij} + 0.031(0.049)\text{full.teares}_{ij} + -0.349(0.082)\text{full.ictuse}_{ij} + -0.005(0.003)\text{>2.5use.socecoind}_{ij} + \\ & -0.013(0.025)\text{>2.5use.paredu}_{ij} + 0.257(0.104)\text{>2.5use.icthome}_{ij} + 0.006(0.014)\text{>2.5use.ictres}_{ij} + \\ & -0.006(0.028)\text{>2.5use.teares}_{ij} + -0.059(0.078)\text{>socave.icthome}_{ij} + 0.004(0.014)\text{>socave.ictres}_{ij} + \\ & 0.032(0.037)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = -0.637(0.211) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.005(0.004) + u_{1j}$$

$$\beta_{2j} = 0.091(0.026) + u_{2j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.162(0.076) & & \\ -0.001(0.001) & 0.000(0.000) & \\ -0.008(0.012) & 0.000(0.000) & 0.003(0.003) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.744(0.023) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = **6498.910(2482 of 2482 cases in use)**

Sweden

$$\text{zscore}_{ij} \sim N(XB, \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + 0.004(0.084)\text{paredu}_{ij} + -0.284(0.299)\text{icthome}_{ij} + 0.037(0.024)\text{ictres}_{j} + \\ & -0.088(0.054)\text{teares}_{j} + -0.198(0.092)\text{ictuse}_{ij} + 0.009(0.008)\text{half.socecoind}_{ij} + 0.006(0.083)\text{half.paredu}_{ij} + \\ & -0.026(0.025)\text{half.ictres}_{ij} + 0.064(0.055)\text{half.teares}_{ij} + 0.048(0.086)\text{half.ictuse}_{ij} + 0.012(0.009)\text{full.socecoind}_{ij} + \\ & 0.034(0.081)\text{full.paredu}_{ij} + -0.024(0.024)\text{full.ictres}_{ij} + 0.042(0.056)\text{full.teares}_{ij} + 0.168(0.105)\text{full.ictuse}_{ij} + \\ & 0.007(0.005)\text{>2.5use.socecoind}_{ij} + -0.065(0.050)\text{>2.5use.paredu}_{ij} + -0.111(0.152)\text{>2.5use.icthome}_{ij} + \\ & -0.007(0.004)\text{>2.5use.ictres}_{ij} + 0.028(0.020)\text{>2.5use.teares}_{ij} + 0.089(0.097)\text{>socave.icthome}_{ij} + \\ & -0.006(0.004)\text{>socave.ictres}_{ij} + -0.010(0.044)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0j} = 0.366(0.570) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = -0.002(0.008) + u_{1j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.096(0.078) & \\ -0.002(0.002) & 0.000(0.000) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.825(0.030) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = **4581.399(1708 of 1708 cases in use)**

UK

$$\text{zscore}_{ij} \sim N(XB,\ \Omega)$$

$$\begin{aligned}\text{zscore}_{ij} = {} & \beta_{0j}\text{cons} + \beta_{1j}\text{socecoind}_{ij} + -0.018(0.044)\text{paredu}_{ij} + 0.201(0.150)\text{icthome}_{ij} + -0.020(0.012)\text{ictres}_{j} + \\ & 0.064(0.040)\text{teares}_{j} + \beta_{6j}\text{ictuse}_{ij} + -0.001(0.004)\text{half.socecoind}_{ij} + 0.032(0.043)\text{half.paredu}_{ij} + \\ & 0.002(0.011)\text{half.ictres}_{ij} + -0.008(0.031)\text{half.teares}_{ij} + -0.027(0.049)\text{half.ictuse}_{ij} + -0.002(0.005)\text{full.socecoind}_{ij} + \\ & 0.059(0.044)\text{full.paredu}_{ij} + -0.001(0.010)\text{full.ictres}_{ij} + -0.044(0.035)\text{full.teares}_{ij} + -0.005(0.060)\text{full.ictuse}_{ij} + \\ & 0.000(0.003)\text{>2.5use.socecoind}_{ij} + 0.036(0.028)\text{>2.5use.paredu}_{ij} + -0.075(0.076)\text{>2.5use.icthome}_{ij} + \\ & 0.016(0.007)\text{>2.5use.ictres}_{ij} + -0.025(0.021)\text{>2.5use.teares}_{ij} + 0.017(0.063)\text{>socave.icthome}_{ij} + \\ & 0.017(0.006)\text{>socave.ictres}_{ij} + -0.039(0.030)\text{>socave.ictuse}_{ij}\end{aligned}$$

$$\beta_{0ij} = -0.795(0.293) + u_{0j} + e_{0ij}$$

$$\beta_{1j} = 0.009(0.004) + u_{1j}$$

$$\beta_{6j} = -0.031(0.052) + u_{6j}$$

$$\begin{bmatrix} u_{0j} \\ u_{1j} \\ u_{6j} \end{bmatrix} \sim N(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.414(0.116) & & \\ -0.002(0.001) & 0.000(0.000) & \\ -0.031(0.019) & 0.000(0.000) & 0.005(0.004) \end{bmatrix}$$

$$\begin{bmatrix} e_{0j} \end{bmatrix} \sim N(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.692(0.018) \end{bmatrix}$$

*-2*loglikelihood(IGLS)* = 8971.696(3451 of 3451 cases in use)

Chapter 8

Results, findings and analysis

8.1 Introduction

In chapter 3 of this project a conceptual framework of human investment was set out, which takes account of the changing nature of human investment provision occurring in tandem with the emergence of the New Economy. Key to the framework developed is the recognition of the paradigmatic shift towards lifelong learning as the guiding principle underpinning human investment provision. This paradigmatic shift introduces a more complex and multi-dimensional approach to human investment than the traditional focus on formal education. Indeed, critical to lifelong learning is the central role of the individual learner rather than the education institution. When considering human investment, it is therefore important to think of all the areas of an individual's life which may contribute to learning, rather than focus on the extent to which individuals participate in a formal educational institution. Needless to say, formal education remains a crucial part of human investment provision, but the paradigm of lifelong learning introduces a number of new dimensions to human investment which require consideration. The introduction of such new dimensions to human investment provision has a number of methodological implications which were explored further in subsequent chapters. In chapters 6 and 7 a number of new indicators were developed and presented for the operationalisation of human investment in the era of the New Economy. These indicators attempted to deal with the multitude of methodological challenges associated with a comprehensive operationalisation of human investment. As such, the new sets of indicators highlighted a number of new dimensions to human investment provision, which were previously left uncovered by traditional indicators of human investment. It is the objective of this chapter to briefly outline the key findings from the indicators developed in the two preceding chapters. In addition, the chapter will include a brief analysis of how the results differ from the findings of more traditional human investment indicators. In particular, the chapter will outline how meeting the methodological challenges associated with a comprehensive operationalisation of

human investment in the era of lifelong learning reveal differences between countries previously left unexamined. It is worth noting, however, that it is beyond the scope of this chapter, and indeed this project, to conduct a comprehensive comparative analysis of human investment provision in the European Union.

8.2 Scorecards and composite indicators

The scorecards and composite indicators developed in chapter 6 allowed for an operationalisation of several features of the conceptual framework outlined in chapter 3. In particular, the scorecards and composite indicators attempted to overcome two main methodological challenges. Firstly, the need to recognise all relevant education environments and include the activities of all relevant stakeholders. Secondly, the need to take account of the specific nature of learning within each of the education environments. Meeting both of these challenges involved overcoming a number of difficulties, but may also reveal a number of interesting differences between countries. Below, the key findings from this exercise will be outlined and discussed.

8.2.1 Period 1

Period 1 is the area that has been studied most in previous comparisons of human investment provision. The main areas that have required operational considerations in this project have been issues surrounding the introduction and utilisation of ICT for human investment purposes. The main transformations to human investment provision in period 1 are thus related to ICT. However, as discussed in chapter 4, these changes constitute quite a considerable transformation of human investment provision in period 1.

In Annex 1 of this chapter, the composite indicators for period 1 are presented in graphs showing countries relative performance in each dimension, as set out in the scorecards and composite indicators.

The composite indicator for the macro-level of period 1, which is constructed from what would be considered 'traditional' indicators of resources devoted to the formal education environment, display only limited variation across the European Union.

Accordingly, while some of the individual sub-indicators of the macro-level of period 1 show greater variation between countries, the overall efforts for this dimension appear reasonably similar.

However, when looking at the other composite indicators, measuring new dimensions to human investment in period 1 emerging from the introduction of ICT as a learning tool, far greater variation is observed. This suggests that some of the new developments in human investment provision in period 1 associated with the introduction of ICT as a new learning tool, are taking place at a very uneven pace across the European Union. At the meso-level of period 1, it is evident that some countries have been far more successful at facilitating change in the formal education environment than others. Furthermore, and perhaps more interesting, there is no clear correlation between the resources devoted to the formal education environment, as measured at the macro-level, and the reshaping of the formal education environment at the meso-level. Notably, a country such as the UK is devoting less resources to the formal education environment at the macro-level than most of its EU counterparts, yet performs relatively very well at the meso-level. In contrast, countries such as France and Germany, which both perform well in terms of resources devoted to the formal education environment at the macro-level, perform relatively poorly at the meso-level. The complex picture of human investment provision is further highlighted when examining the micro-level of period 1. Again, there appears to be much greater variation in the performance of the EU member states at this level compared to the macro-level. Moreover, the relative performance at the micro-level is not strongly correlated to the relative performance at the macro-level.

In addition, it is worth noting that the relative performance of countries at the micro-level is not uniform across the different education environments. While some countries perform well at the micro-level of the formal education environment, they may perform relatively less well for the informal education environment, while other countries displays the opposite pattern. For example, in Germany the formal education environment is performing relatively poorly at the meso- and micro-level despite many resources devoted at the macro-level. However, the performance in the informal education environment is relatively strong.

These findings show that the macro-level indicators for period 1 are inadequate proxies for tracking the transformation of human investment provision in period 1 resulting from the introduction of ICT. As such, the findings support the efforts in this project to operationalise the changes to human investment provision in their own right.

However, before drawing too strong conclusions from the composite indicators, a word of caution is required. It was noted in chapter 6 that for some of the composite indicators, some of the countries displayed significant sensitivity to the relative weights attached to sub-indicators. This suggests that the performance of some countries within each dimension is not uniform. For example, a country such as Luxembourg has a very high level of ICT resources at the meso-level, but performs poorly on the utilisation of these resources. The outcome of the sensitivity analysis thus alerts us to the areas of the framework where the analysis of the composite indicators ought to be complemented with a more detailed examination of the scorecards.

8.2.2 Period 2

Period 2 of the conceptual framework represents a segment of human investment provision that is critical to the paradigm of lifelong learning. However, it is also the part of the conceptual framework which has hitherto been most neglected in the analysis of human investment. In Annex 1 of this chapter, the composite indicators for period 2 are presented in graphs showing countries relative performance in each dimension.

The indicators for period 2 show similar, if not more, complexity to that evident for period 1. However, already at the macro-level, great variation is observed across the member states of the EU. We can thus see great differences between the best performing country, Denmark, and the country at the bottom, UK. Accordingly, while the countries are performing very similarly on the composite indicator for the macro-level for period 1, the commitment to human investment in period 2 at the macro-level is more varied across the EU.

At the meso-level, however, a different picture emerges. Notably, while the UK is ranked last of the countries at the macro-level, the country is among the top ranking countries at the other levels of aggregation in period 2. While the amount of public resources devoted to adult education and training in the UK is thus very limited, there appears to be much more opportunities for human investment and learning facilitated in the non-formal education environment at the meso-level. In contrast, Germany is performing well above average at the macro-level (note that the German expenditure data only includes expenditure on unemployed, therefore underestimating the country's performance at the macro-level), while performing below average at the meso-level.

The micro-level of period 2 reveals further differences between countries. One would perhaps expect there to be a strong correlation between the efforts to facilitate learning at the meso-level of the non-formal education environment, and the learning activities of individual employees at the micro-level. Indeed, for most countries this appears to be the case. However, it is of interest to note that a country such as the UK, which performs relatively strongly at the meso-level, is taking a more middling position at the micro-level of the non-formal education environment. This may indicate that the efforts at the meso-level do not translate as successfully into learning experiences at the micro-level in the UK as compared to Finland, Luxembourg and Germany.

The composite indicator for the micro-level of the informal education environment is limited to the measurement of the availability and utilisation of ICT. A lack of suitable data prevented the operationalisation of other features of the informal education environment. However, notwithstanding these limitations, clear differences are evident between countries in the extent to which they are making use of the new learning opportunities in the informal education environment emerging with the introduction of ICT as a new learning tool. Denmark and Sweden are ahead in a league of their own, while most of the other member states are all closer to the EU average.

The composite indicator for the micro-level of the formal education environment measures the participation rate of adults in formal education. While it is doubtful what

role the formal education environment plays in period 2, it is clear that stark differences prevail across the EU. One would perhaps expect that formal education would take on a more significant role in period 2, as the need to retrain and gain more generic skills increases. This need may be more pressing in some countries rather than others, explaining the differences.

Interpreting the indicators for period 2 further, the indicators for the different levels of aggregation in period 2 show crudely how the primary responsibility for human investment is divided between the state, employer and individual learner. While countries such as Denmark display a strong performance in all education environments and at all levels of aggregation, others have a very different division of which actors facilitate human investment provision. For example, in the non-formal education environment countries such as France and the UK perform relatively better at the meso-level than the micro-level. This suggests that the efforts of the employers to facilitate training and learning do not translate directly into similar relative performance at the micro-level of the same education environment. In contrast, Finland performs relatively much better at the micro-level of the non-formal education environment than the meso-level. Accordingly, individual employees in Finland are undertaking efforts for human investment in an education environment that is not as strongly facilitated for learning at the organisational level, as other countries.

As with period 1, the sensitivity analysis conducted in chapter 6 alerts us to the areas where it may be appropriate to complement the analysis of the composite indicators with a closer scrutiny of the scorecards. The first part of the sensitivity analysis revealed which countries were particularly sensitive to changes in the weights attached for the construction of the composite indicator. The second part of the sensitivity analysis revealed which sub-indicators made the composite indicators particularly sensitive for each country. It was shown in this second part of the sensitivity analysis that it was different sub-indicators causing the sensitivity for the EU member states. These differences may be indicative of differences in the relative priority, at the political level or by employers and individual learners, attached to each sub-indicator. A more thorough comparison of human investment therefore needs to look beyond the composite indicators, and complement these with the findings of the

sensitivity analysis and indicators presented in the scorecards revealing more subtle differences. The sensitivity analysis should therefore not merely be considered an optional addition to the construction of composite indicators, but is an essential part of the successful operationalisation of human investment.

Hence, it is of interest to note that the composite indicator for the meso-level of the non-formal education environment may hide significant differences among the sub-indicators. The composite indicator for the meso-level of period 2 is constructed from sub-indicators covering expenditure and commitment to vocational training and a set of indicators aiming to capture learning organisational features. However, there appears to be no clear correlation between the commitment to vocational training and the extent to which the organisation is geared towards learning. For example, France performs well above the EU average on the indicators capturing commitment to vocational training, but only average or below average on the indicators measuring the existence of learning organisations. In contrast, Greece performs very poorly on the indicators on vocational training provided by employers, yet is closer to the EU average, or even above the EU average, on learning organisation indicators. In fact, this latter pattern emerges for all the Southern European countries. Hence, in Southern European countries employers appear to be relatively better at establishing organisational structures conducive to learning than committing themselves to vocational training for employees. In contrast, in a country such as France the facilitation of human investment by employers appear to be relatively more focused on vocational training for employees, with relatively less emphasis on the creation of organisational structures conducive for learning in the workplace. Explanations for such differences may be found in corporate cultures, but also variations in legislative and institutional frameworks and labour markets.

Accordingly, the scorecards reveal that even within a dimension of human investment, there are differences between countries in their approach. In contrast to previous measurements of the non-formal education environments, which have focused entirely on vocational training, the indicators presented in the scorecards reveal the different ways in which employers can facilitate human investment.

Looking at the indicators for both periods, the findings suggest that the focus on formal education at the macro-level, which has been common practice, fail to capture critical differences in human investment provision between countries. In particular, the emphasis in this project on operationalising the non-formal and informal education environments in their own right, and the processes of transformation to human investment provision in all education environments, seem to add to our understanding of human investment provision in the EU.

Moreover, it is of interest to note that the relative performance of countries is different in the different dimensions of the human investment framework. Notably, a country such as the UK performs below average at the macro level of both periods, but is in the top half of the other dimensions. In contrast, France and Germany devote a lot of resources to human investment at the macro-level, but perform worse at the meso-level of both periods.

This would perhaps suggest that this is merely due to poor or better performance by the countries, and that the relevant countries should do more to improve human investment in the dimensions in which they do not perform well. This would be the conclusion to be drawn from a traditional approach to benchmarking. After all, the use of indicators is supposed to inform us of areas where countries are performing relatively better or worse than other member states, and highlight areas in need of further improvements.

However, there may be other reasons for some countries performing particularly well in some of the dimensions and worse in others. Indeed, different dimensions of the human investment framework may be better suited to different contexts, implying that different countries maybe should pursue different dimensions, or different features within each education environment. It is thus debatable whether it is appropriate to assume that the frameworks and systems of human investment in each period are symmetrical across the EU. Previous studies (Estevez-Abe et al, 2001) of human investment provision, prior to the paradigmatic shift to lifelong learning, found that the institutional framework in a country plays a critical part in shaping differences in human investment. With the increased multi-dimensionality of human investment provision associated with the paradigm of lifelong learning such differences may be

brought to the fore. This problem was recognised in this project as an important implication of the multi-dimensionality of human investment provision. Accordingly, the effort to operationalise human investment in this project has not limited itself to the indicators presented in chapter 6, but developed a more novel set of complementing indicators in chapter 7. These reveal a number of interesting differences between countries.

8.3 Coefficients and interaction terms

The objective of the analysis conducted in chapter 7 was to develop a set of indicators that would capture the more complex transformations of human investment provision resulting from the introduction of ICT as a new learning tool. Although limitations on data and methodological considerations only allowed for an operationalisation of period 1, it is evident from chapter 7 that the countries do not only perform differently across the dimensions of human investment, but that the role of the various dimensions, and sub-indicators within the different dimensions, take on different significance across the European Union.

In Annex 2 of this chapter, the values of the coefficients for the individual variables for the different countries are presented, together with the t-value estimating the significance of the coefficient. These coefficients refer to the role of each of the used variables for human investment provision, as measured by their statistical relationship with human investment outcomes.

Notwithstanding the difficulties with the data used, the results presented in the tables in the annex show that several of the variables and interaction terms are statistically significant for education outcomes in a number of countries. Perhaps more interestingly, different variables are statistically significant in different countries. It is evident that in some countries the variables for the informal education environment are more significant, and the coefficients have a greater value, than the variables for the formal education environment, whilst in other countries the formal education environment appear more significant. However, even within the informal education environment there are differences between countries in which variables are of significance. While the socio-economic indicator is statistically significant for

Belgium, Greece, Luxembourg, Portugal and the UK, it is the indicator for parental education that is statistically significant for Germany, Greece and Spain. With regard to the introduction of ICT as a new learning tool, it is evident that the availability of ICT in the informal education environment is statistically significant in Austria and Belgium. In contrast, the availability of ICT in the formal education environment is statistically significant for Greece, Ireland and Luxembourg, while the utilisation of ICT in the formal education environment is statistically significant for Belgium, Denmark, Greece, Portugal, Spain and Sweden. In addition, the sign of the coefficients for the ICT variables differ between countries. For example, the coefficient for ICT use in the formal education environment is positive for Belgium, Denmark, Portugal and Spain, while it is negative for Greece and Sweden. The sign of the coefficient can be interpreted in different ways. While it is tempting to infer from these findings that ICT has a positive impact on educational outcomes in some countries and negative in others, it may also be the case that ICT resources are allocated in a manner favouring less performing students in some countries. The coefficient only indicates a relationship between the dependent and explanatory variable, it does not necessarily say something about the nature of causality. This may also be the case for the coefficients for teacher resources. Accordingly, the indicators developed in chapter 7 should be interpreted with care.

The view that there are significant differences in the role played by the relevant education environments of period 1 gains further support when examining the residuals of the model. These are also presented in Annex 2 of this chapter.

Interestingly, the residuals show up as highly statistically significant, yet with great differences between countries in at what level the residuals are explained. This suggests that variation in educational performance in some countries are mainly explained at the school level as opposed to the student level, whilst other countries display the opposite pattern. The intra-school correlation is an indicator that summarises such differences between countries. As can be seen, the intra-school correlation varies from 0.717 in Ireland, suggesting that the school-level is important in explaining variations in test performance, to 0.1789 in Spain, indicating that the vast majority of the variation is explained at the student-level. However, it should be noted that the low explanatory power of the school-level in some countries is due to a

very low number of student samples from each school. The usefulness of the residuals as indicators of differences between countries is significantly limited as a result.

Some other interesting findings of the analysis in chapter 7 are with regard to the interaction terms presented in Annex 2 of this chapter. The interaction terms are indicators of the transformation of the wider human investment framework resulting from the introduction of ICT. Indeed, the indicators developed and presented in chapter 7 show that in some countries the real significance of ICT as a learning tool is in its interaction with other factors shaping human investment provision.

Great differences between the EU member states can be observed. The value, significance and sign of the interaction terms differ greatly between countries. Hence, the interaction terms with the categorical variable of ICT in the home is very different for the various member states. For example, countries such as Denmark, Finland, Greece, Ireland and Sweden have a positive interaction term for ICT in the home and the socio-economic index and parents education, while for the other countries at least one of these interaction terms are negative. When the interaction terms are positive, it indicates that the availability of ICT in the home increases the value of the coefficient for the variables measuring socio-economic level and parental education. When the interaction terms are negative, the coefficients for these two explanatory variables, and thus their influence on test scores, are reduced as a result of the availability of ICT in the home. A further example is the impact of having ICT resources in the home on the coefficient of ICT use in the formal education environment, which is positive in the Netherlands but negative in Denmark, France and Spain. The latter suggests that the contribution of ICT use in the formal education environment diminishes as the availability of ICT in the informal education environment increases. In contrast, the positive interaction term in the Netherlands lends support to the arguments presented in chapters 3 and 4 that the impact of ICT may lie in the establishment of networks between the formal and informal education environments. Accordingly, the effective use of ICT in one environment is to some extent dependent on the availability and use of ICT in the other relevant environment for that period. However, before too strong conclusions are inferred, a note of caution is required. It may be the case that the results for the interaction terms may merely reflect 'noise' in the data. The differences observed between countries may therefore be indicative of

noise effects rather than differences in actual interaction effects. This may particularly be the case for countries with small samples. By including a number of more complex interaction terms in the analysis, the smaller samples are stretched to the limits, which may be the reason for differences in the results for the interaction terms. It would thus be of interest to examine whether the differences between countries in the sign, value and significance of the interaction terms persist when conducting similar analysis with other data sets. Notably, as the next PISA data set (2004) becomes available, it would be of interest to see if the interaction terms are significant and different between countries in an analysis similar to the one conducted in chapter 7 of this project. As the analysis currently stands, the interaction terms should be interpreted with caution. As previously discussed, there are a number of limitations to the findings of the analysis in chapter 7, and the issue of noise needs to be taken into account. Notwithstanding such limitations, it may be the case that the differences observed between countries in the interaction terms may be indicative of substantial differences between countries in the way the introduction of ICT transforms the formal and informal education environments of period 1. Accordingly, the important conclusion to draw from the findings presented here is that such effects may not be uniform across the EU, and that policy makers should be aware of this.

In sum, the interaction terms arrived at in this project suggest that as ICT resources and utilisation increases in the two education environments, the wider education environments in the EU member states will, ceteris paribus, go through different processes of transformation. Such differences can be of as much importance to policymakers and for benchmarking purposes as differences in actual levels of ICT resources and utilisation.

Unlike existing indicators of ICT for human investment, the indicators developed in chapter 7 capture some wider systemic and institutional differences between countries whilst also attempting to measure the wider changes to human investment provision resulting from the introduction of ICT. As is evident from the results, these changes are very different between countries, and the relative performance of countries on the various coefficients and interaction terms differ significantly from the indicators measuring the mere availability of ICT in the formal and informal education environments. This highlights the limitations of merely measuring the availability and

use of ICT. Clearly, there are greater transformations of the human investment framework which are not captured by the simpler indicators presented in chapter 6. This would be expected given the particular methodological challenges that the indicators developed in chapter 7 are attempting to meet.

The fact that some of the coefficients and interaction terms are statistically significant, despite the poor quality of the data and complexity of the model, suggests that such indicators may be of great interest to policymakers in the future. It is in this light that the contribution of chapter 7 should be seen. However modest the initial expectations, it is the argument of this project that the results obtained highlight the need to reconsider the indicators used for human investment, given the complex qualitative change of human investment provision. If we are to satisfactory capture and track such qualitative change for the purposes of successful policymaking, more sophisticated indicators are needed. The indicators developed in chapter 7 and presented here is an initial attempt at developing such indicators. The contribution of this project is thus more a methodological one than in the findings themselves. However, the fact that several of the coefficients and interaction terms are statistically significant in some countries shows the value of introducing such indicators.

8.4 Explaining differences in performance

In combination, the findings of chapter 6 and 7 reveal great differences in human investment provision across the EU. However, the relative performance of countries is not uniform across dimensions and features of the human investment framework. Accordingly, a country will perform relatively better in some education environments and dimensions of the human investment framework than in others. It would be tempting to conclude that this merely reflected differences in efforts between countries, and that countries should do their best to improve the areas of the framework in which their performance is relatively weak. However, it may rather be the case that the findings in this project support the analysis of education and training put forward by institutional economists such as Estevez-Abe et al (2001). As noted in chapter 2, their analysis suggests that the nature of human investment provision is shaped by wider institutional differences, and that such differences need to be taken into account when analysing the role of human investment.

Indeed, we would expect that the decisions to invest in human skills and abilities by the relevant stakeholders are likely to be shaped by the wider institutional framework. Estevez-Abe et al (2001) suggests that the incentive by individuals to undertake particular forms of human investment, will depend on how the labour market and wider socio-economic context rewards different skills and abilities. In other words, the differences observed between countries in the relative performance across dimensions of the human investment framework may reflect wider socio-economic differences between countries. For example, an environment in which employers are secured a return on an investment in the skills of employees is likely to see a high performance on the meso-level indicators of period 2, notably on the expenditure levels on training. Similarly, the extent to which an employee is willing to invest in skills of use for a specific job through the non-formal education environment, rather than investing in more general skills conferred by the formal education environment, will depend on the extent to which the employee feels secure in the job for which the specific skills are required. However, the extent to which employers and employees are likely to have such security will depend on the ability of employees to move to different jobs and gain a higher salary as a result of their required skills and whether employers can easily make employees redundant. Such security is, according to Estevez-Abe et al (2001), unlikely to be present in a purely market-based economy in which employment is agreed individually between employers and employees and there are few means of employment and unemployment protection. A labour market where wages are predominantly determined through individual negotiations between employers and employees will create an environment in which employees will try to exploit any gained skills to their advantage by moving between firms, hence creating a disincentive for employers to invest in training for employees. In addition, a labour market with little employment protection and only limited protection during periods of unemployment, creates an incentive for individuals to invest in broad generic skills which allows the individual to move across sectors and types of employment, whilst also creating a disincentive for employees to invest in sector specific and firm specific skills.

In contrast, an economy in which there are high levels of employment and unemployment protection may reduce the risks to the individual employee associated with investing in firm- or industry-specific skills through the non-formal education

environment. Moreover, if wages are determined by employee and employer organisations centrally as opposed to market-based relationship between the individual employee and employer, there may be the necessary security to both employers and employees that makes it worthwhile for either or both parties to invest in skills. As noted by Estevez-Abe (2001), through centralised agreements it is possible for employer and employee organisations to reach agreements that introduces a degree of job protection in the labour market. Moreover, "to the extent that collective bargaining systems are designed to prevent poaching, they limit the ability of individual firms to pay wages that are significantly above the negotiated rate" (Estevez-Abe et al, 2001:155). Hence, if wages are fairly uniform across any given type of employment, and firms and employees are less able to enter into individual agreements on pay, the salary achievable for the individual employee will be more similar in all firms, irrespective of the industry-specific or firm-specific skills acquired. There will thus be less of an incentive for the individual employee to move to a different employer, in effect limiting labour mobility. Such a situation will add an incentive for the employer to invest in the more industry-specific and firm-specific skills, which are more likely to be conferred at the meso-level of the non-formal education environment. In other words, an institutional framework where the agreements are reached through non-market based mechanisms can allow for cooperation between employers as well as between employers and employees in ensuring the availability of the required skills for the economy. Consequently, "For firms pursuing product market strategies which depend heavily on firm- and industry-specific skills, promise of employment and unemployment security can thus provide a cost-effective path to improving the firms' competitive position in international markets [...]. Contrary to conventional neoclassical theory, which sees efforts to increase protection against job loss as an interference with the efficient operation of labour markets, measures to reduce future uncertainty over employment status - hence uncertainty over future wage premiums – can significantly improve firms' cost effectiveness" (Estevez-Abe, 2001:152-153). We would thus expect there to be a relationship between the performance in the different dimensions of the human investment framework and the wider institutional framework.

Moreover, while institutional differences may always have played a role in shaping human investment provision, it could be argued that the emergence of a more multi-

dimensional human investment provision brings these institutional differences to the fore. In period 1, this may mean some economies have a greater need for the skills conferred by the formal education environment, and will devote more resources to this segment of the human investment framework. However, in other countries there may be a relatively greater emphasis on the non-formal education environment. For example, the introduction of learning organisation structures may be more appropriate for some sectors rather than others. Indeed, learning organisations are supposed to be particularly suitable for companies in need of perennial adaptation to changing conditions (Senge, 1990). Some sectors are inevitably subject to greater change than others. These sectors may play a relatively greater role in the UK than France and Germany. If so, we would expect learning organisations to be more widespread among UK firms compared to France and Germany. Hence, the work of Estevez-Abe et al (2001) suggests that the differences observed across the member states of the European Union in the indicators presented in chapter 6 may be explained by differences in labour markets, social protection and wider political economy.

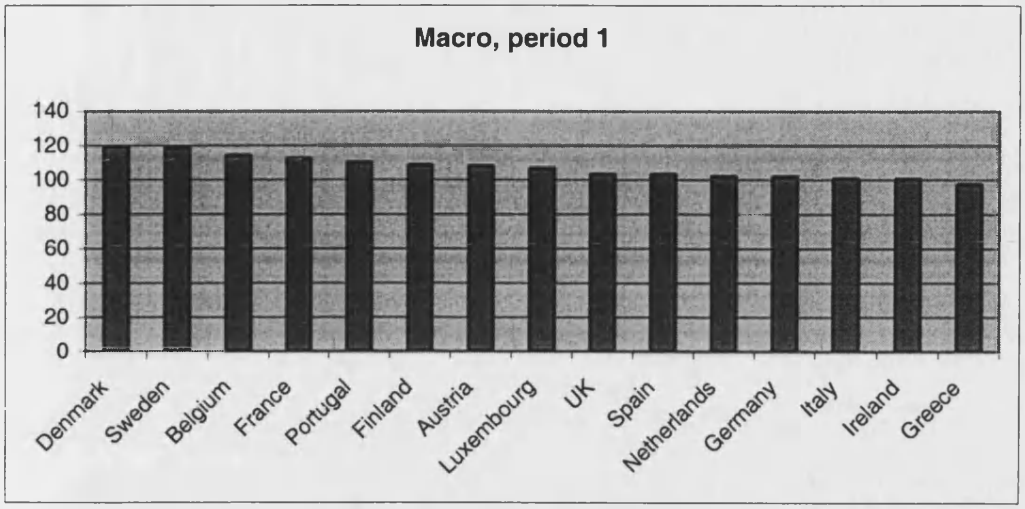
The relevance of the argument presented by Estevez-Abe et al (2001) for the findings of this project may be further highlighted when exploring the results of the indicators developed in chapter 7. Accordingly, it was argued that the coefficients from the analysis in chapter 7 could be considered indicators of differences in human investment frameworks. The sign of the coefficients on the key explanatory variables thus say something about how the system of human investment provision and institutional framework places the emphasis and balance between features of the formal and informal education environments. For example, a country for which the coefficients for the socio-economic indicator, parental education indicator and/or the indicator for ICT in the home are high and significant compared to the coefficients for the formal education variables, indicates that the informal education environment plays a relatively greater role in shaping test scores. The policy response to such findings could be two-fold. One is to recognise that the informal education environment is more important for educational outcomes, and improve the variables for the informal education environment for as wide a section of the population as possible (although this is likely to require significant transformations of society). Alternatively, one could ask why the coefficients for the informal and formal education environments are of that particular sign, value and significance. Are there

processes or mechanisms in place, that give pupils from high performing informal education environments a great advantage? The coefficients should therefore not be considered a given, but shaped by the nature of the human investment system in period 1. These issues are further discussed in chapter 9.

In sum, the key argument presented here is that the configuration of the human investment framework appear to differ between member states of the EU. However, this should perhaps not surprise us, as the human investment framework, with all its complexities, exists within a wider institutional framework that influences the nature of human investment provision. This has a number of implications for policymaking, but also for the benchmarking of human investment. While there may be agreement on what education environments and stakeholders are of relevance, their role in the wider human investment framework is unique to each country. Consequently, policymakers in different countries should not necessarily target the same indicators and benchmarks with equal fervour. In order to facilitate the most appropriate policies for human investment we need indicators, which can guide policymakers to exploit the strengths of their particular human investment framework and wider institutional framework. For example, in some countries the marginal gains to education outcomes may be greater from increasing ICT resources in the formal education environment, while in other countries efforts should be on increasing availability of ICT in the informal education environment. Indeed, it may be the case that the interactions between the two education environments are such that changes in the nature of one education environment changes the role of particular features of other education environments. The objective of the analysis in this project has been to operationalise these more complex facets of human investment provision in the era of the New Economy, such as to provide policy makers and other stakeholders with a more comprehensive picture of human investment provision in each member state.

Accordingly, the indicators developed in this project take us some way forward in operationalising human investment in a manner that is consistent with the complexities of the multi-dimensional human investment provision associated with the paradigm of lifelong learning. In the chapter that follows, the implications of the conceptual and operational efforts in this project will be further examined.

Annex 1


Macro, period 1
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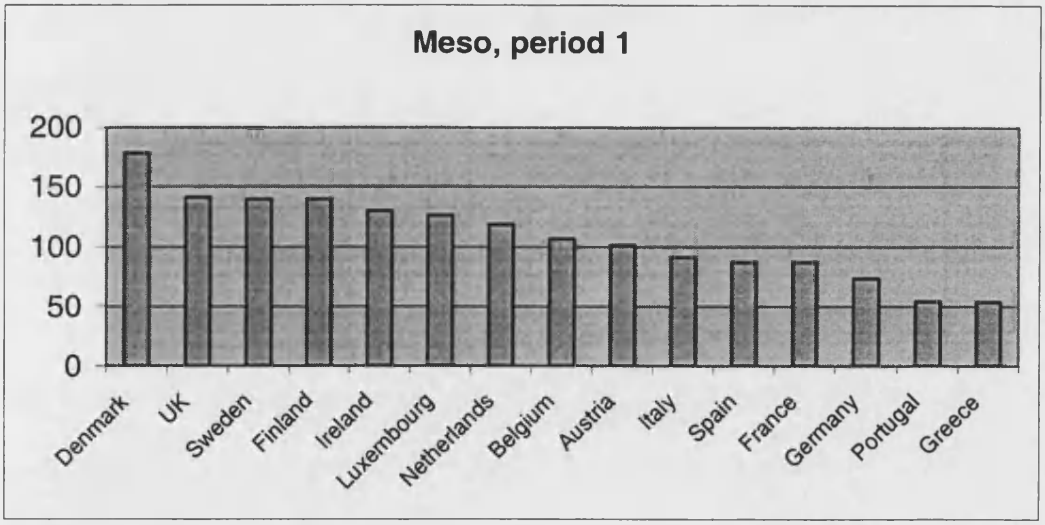
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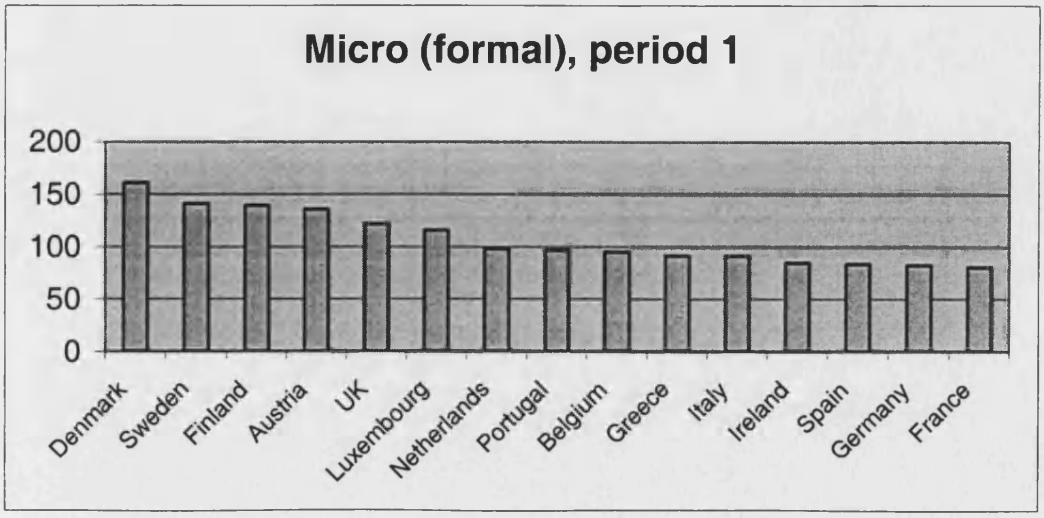
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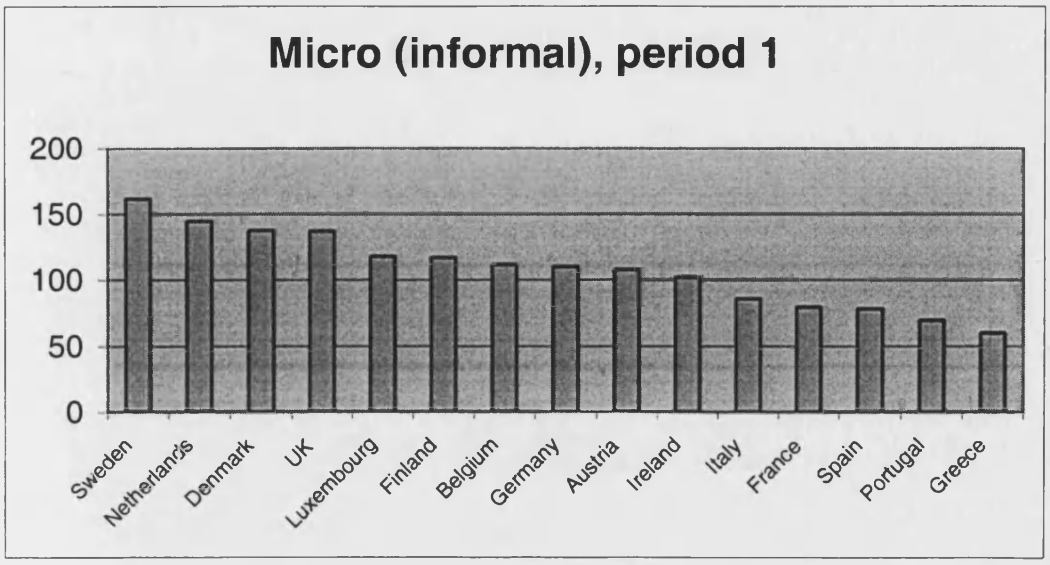
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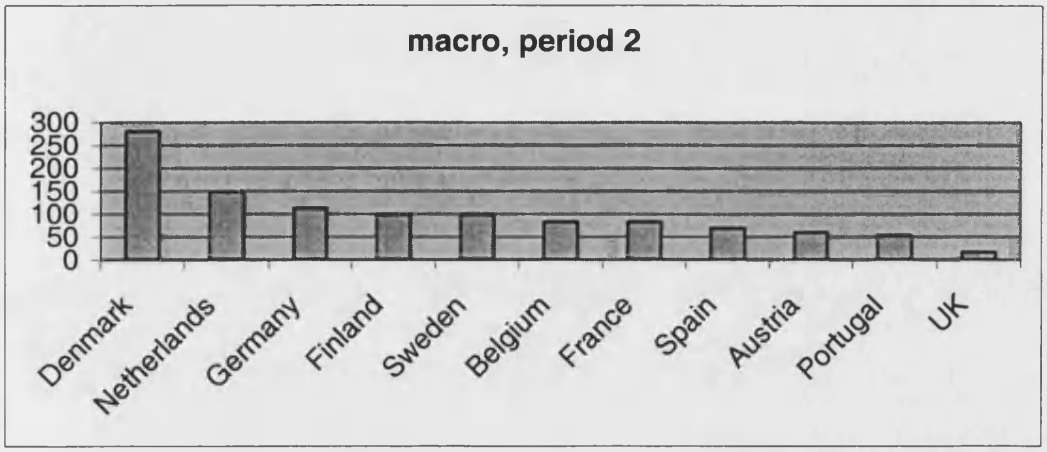
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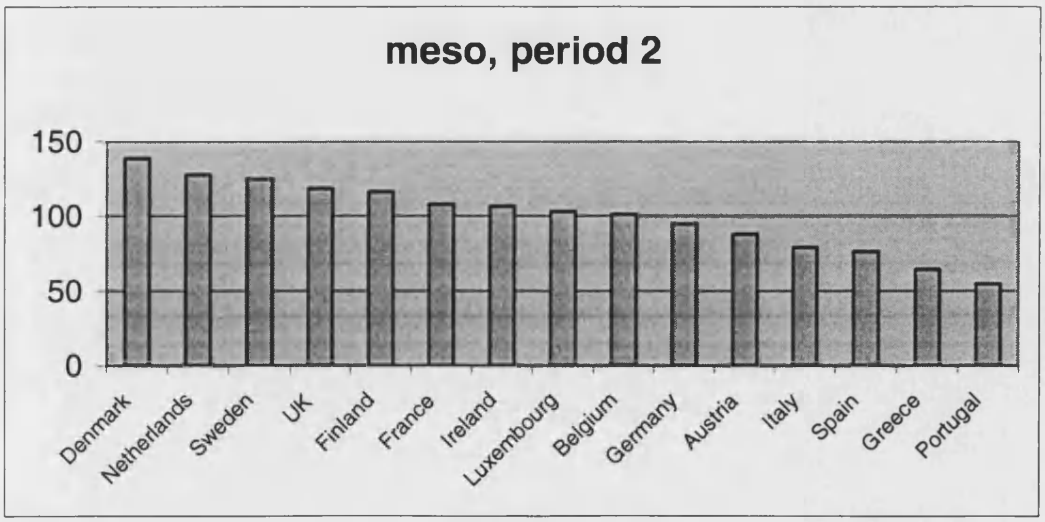
meso, period 2
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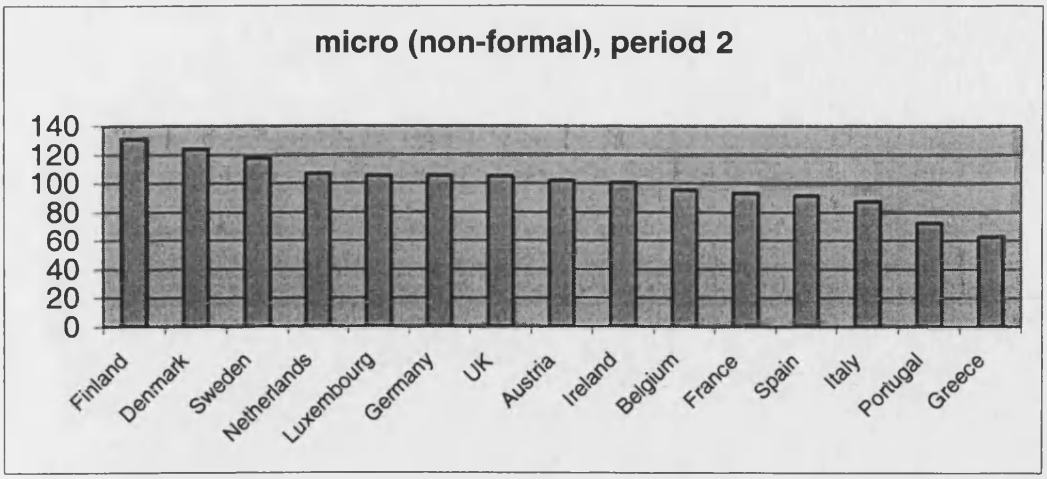
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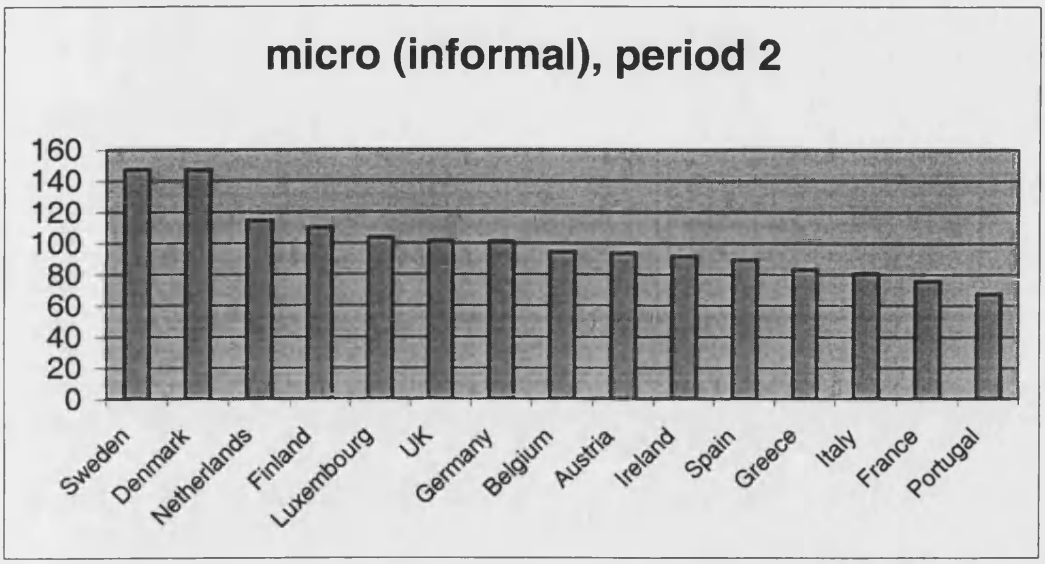
micro (informal), period 2
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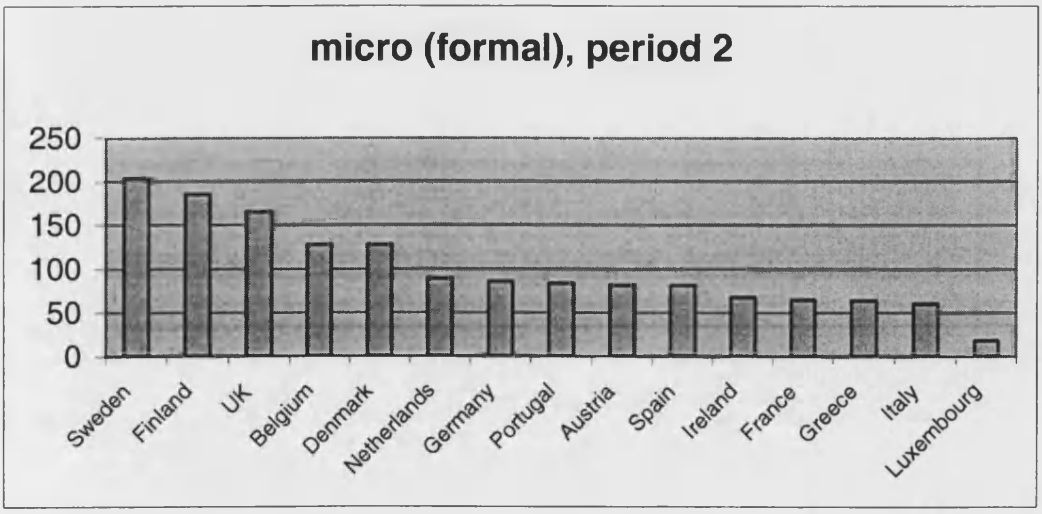
micro (formal), period 2
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Italy
Luxembourg

Annex 2

	Socecoind	standard error	t-statistic
Country			
Austria	0.006	0.005	1.2
Belgium	0.008	0.003	**2.666666667**
Denmark	-0.003	0.01	-0.3
Finland	0.000	0.006	0
France	-0.007	0.007	-1
Germany	0.004	0.004	1
Greece	0.006	0.002	**3**
Ireland	0.003	0.004	0.75
Italy	0.003	0.004	0.75
Luxembourg	0.025	0.008	**3.125**
Netherlands	0.013	0.01	1.3
Portugal	0.013	0.004	**3.25**
Spain	0.005	0.004	1.25
Sweden	-0.002	0.008	-0.25
UK	0.009	0.004	**2.25**

	Paredu	standard error	t-statistic
Country			
Austria	0.041	0.066	0.621212121
Belgium	0.027	0.029	0.931034483
Denmark	0.057	0.103	0.553398058
Finland	0.092	0.06	1.533333333
France	0.058	0.066	0.878787879
Germany	0.095	0.043	**2.209302326**
Greece	0.049	0.021	**2.333333333**
Ireland	0.055	0.031	1.774193548
Italy	0.002	0.036	0.055555556
Luxembourg	0.085	0.055	1.545454545
Netherlands	0.027	0.097	0.278350515
Portugal	-0.027	0.026	-1.03846154
Spain	0.091	0.026	**3.5**
Sweden	0.004	0.084	0.047619048
UK	-0.018	0.044	-0.40909091

	ICThome	standard error	t-statistic
Country			
Austria	0.357	0.158	**2.259494**
Belgium	0.451	0.126	**3.579365**
Denmark	0.317	0.291	1.089347
Finland	-0.207	0.255	-0.81176
France	0.230	0.307	0.749186
Germany	0.017	0.166	0.10241
Greece	-0.214	0.118	-1.81356
Ireland	0.426	0.242	1.760331
Italy	-0.023	0.165	-0.13939
Luxembourg	-0.254	0.265	-0.95849
Netherlands	-0.306	0.228	-1.34211
Portugal	0.040	0.104	0.384615
Spain	0.242	0.147	1.646259
Sweden	-0.320	0.295	-1.08475
UK	0.186	0.147	1.265306

	teares	standard error	t-statistic
Country			
Austria	-0.019	0.017	-1.11765
Belgium	-0.141	0.02	**-7.05**
Denmark	-0.026	0.051	-0.5098
Finland	-0.037	0.047	-0.78723
France	-0.004	0.03	-0.13333
Germany	0.04	0.048	0.833333
Greece	-0.073	0.016	**-4.5625**
Ireland	0.011	0.063	0.174603
Italy	-0.255	0.059	**-4.32203**
Luxembourg	-0.132	0.071	-1.85915
Netherlands	-0.311	0.106	**-2.93396**
Portugal	0	0.001	0
Spain	-0.127	0.037	**-3.43243**
Sweden	-0.088	0.054	-1.62963
UK	0.064	0.04	1.6

	ICTres	standard error	t-statistic
Country			
Austria	0.006	0.01	0.6
Belgium	0.008	0.01	0.8
Denmark	0.011	0.023	0.478261
Finland	-0.013	0.02	-0.65
France	-0.02	0.02	-1
Germany	-0.04	0.03	-1.33333
Greece	0.026	0.013	**2**
Ireland	-0.048	0.016	**-3**
Italy	0.01	0.023	0.434783
Luxembourg	0.127	0.057	**2.22807**
Netherlands	0.018	0.039	0.461538
Portugal	0.002	0.003	0.666667
Spain	-0.006	0.017	-0.35294
Sweden	0.037	0.024	1.541667
UK	-0.02	0.012	-1.66667

	ICTuse	standard error	t-statistic
Country			
Austria	0.051	0.058	0.87931
Belgium	0.114	0.044	**2.590909**
Denmark	0.202	0.101	**2**
Finland	0.002	0.078	0.025641
France	0.207	0.119	1.739496
Germany	-0.063	0.066	-0.95455
Greece	-0.086	0.039	**-2.20513**
Ireland	0.065	0.06	1.083333
Italy	0.066	0.06	1.1
Luxembourg	0.128	0.083	1.542169
Netherlands	-0.282	0.161	-1.75155
Portugal	0.097	0.038	**2.552632**
Spain	0.244	0.053	**4.603774**
Sweden	-0.198	0.092	**-2.15217**
UK	-0.031	0.052	-0.59615

	Schoolres	Standard error	t-statistic
Country			
Austria	0.586	0.153	**3.83**
Belgium	0.255	0.112	**2.276785714**
Denmark	0.622	0.306	**2.032679739**
Finland	0	0	0
France	0.195	0.137	1.423357664
Germany	0.426	0.05	**8.52**
Greece	0.357	0.101	**3.53**
Ireland	2.082	1.054	1.975332068
Italy	1.154	0.876	1.317351598
Luxembourg	0	0	0
Netherlands	0.537	0.192	**2.796875**
Portugal	0.212	0.104	**2.038461538**
Spain	0.162	0.076	**2.131578947**
Sweden	0.096	0.078	1.230769231
UK	0.414	0.116	**3.568965517**

	Studentres	Standard error	t-statistic
Country			
Austria	0.583	0.021	**27.76**
Belgium	0.476	0.014	**34**
Denmark	0.802	0.034	**23.58823529**
Finland	0.864	0.033	**26.18181818**
France	0.871	0.048	**18.14583333**
Germany	0.451	0.015	**30.06666667**
Greece	0.561	0.019	**29.53**
Ireland	0.823	0.028	**29.39285714**
Italy	0.531	0.018	**29.5**
Luxembourg	0.803	0.035	**22.94285714**
Netherlands	0.42	0.024	**17.5**
Portugal	0.599	0.023	**26.04347826**
Spain	0.744	0.023	**32.34782609**
Sweden	0.825	0.03	**27.5**
UK	0.692	0.018	**38.44444444**

	intra-school correlation
Country	
Austria	0.52135
Belgium	0.348837209
Denmark	0.436797753
Finland	0
France	0.182926829
Germany	0.485746864
Greece	0.388888888
Ireland	0.716695353
Italy	0.684866469
Luxembourg	0
Netherlands	0.561128527
Portugal	0.261405672
Spain	0.178807947
Sweden	0.104234528
UK	0.374321881

			ICThome-socecoind			
Country	**Half**	**standard error**	**t-statistic**	**Full**	**standard error**	**t-statistic**
Austria	0.001	0.006	0.166667	-0.003	0.007	-0.42857
Belgium	0.000	0.003	0	0.000	0.003	0
Denmark	0.002	0.009	0.222222	0.008	0.01	0.8
Finland	0.002	0.006	0.333333	0.004	0.008	0.5
France	0.009	0.008	1.125	0.010	0.01	1
Germany	-0.002	0.004	-0.5	-0.001	0.005	-0.2
Greece	0.004	0.003	1.333333	0.006	0.004	1.5
Ireland	0.001	0.005	0.2	0.006	0.006	1
Italy	-0.003	0.004	-0.75	-0.001	0.005	-0.2
Luxembourg	-0.003	0.007	-0.42857	-0.005	0.009	-0.55556
Netherlands	-0.009	0.01	-0.9	-0.007	0.011	-0.63636
Portugal	0.001	0.004	0.25	-0.005	0.005	-1
Spain	0.002	0.004	0.5	0.004	0.005	0.8
Sweden	0.009	0.008	1.125	0.012	0.009	1.333333
UK	-0.001	0.004	-0.25	-0.002	0.005	-0.4

			ICThome-paredu			
Country	Half	standard error	t-statistic	Full	standard error	t-statistic
Austria	-0.029	0.062	-0.46774	-0.057	0.068	-0.83824
Belgium	0.013	0.029	0.448276	-0.029	0.036	-0.80556
Denmark	0.195	0.078	**2.5**	0.128	0.082	1.560976
Finland	0.044	0.058	0.758621	0.044	0.057	0.77193
France	-0.02	0.07	-0.28571	0.03	0.092	0.326087
Germany	0.011	0.044	0.25	0.018	0.051	0.352941
Greece	0.003	0.03	0.1	0.036	0.038	0.947368
Ireland	0.018	0.038	0.473684	0.053	0.04	1.325
Italy	0.019	0.038	0.5	0.028	0.047	0.595745
Luxembourg	0.049	0.058	0.844828	-0.01	0.058	-0.17241
Netherlands	-0.005	0.097	-0.05155	0.012	0.1	0.12
Portugal	0.018	0.033	0.545455	0.105	0.04	**2.625**
Spain	-0.009	0.029	-0.31034	0.023	0.037	0.621622
Sweden	0.006	0.083	0.072289	0.034	0.081	0.419753
UK	0.032	0.043	0.744186	0.059	0.044	1.340909

			ICThome-teares			
Country	Half	standard error	t-statistic	Full	standard error	t-statistic
Austria	-0.003	0.015	-0.2	0.007	0.016	0.4375
Belgium	-0.017	0.014	-1.21429	-0.038	0.016	**-2.375**
Denmark	0.039	0.035	1.114286	0.014	0.038	0.368421
Finland	0.033	0.042	0.785714	0.022	0.052	0.423077
France	0.025	0.031	0.806452	-0.004	0.035	-0.11429
Germany	0.017	0.033	0.515152	-0.012	0.04	-0.3
Greece	-0.002	0.012	-0.16667	-0.001	0.014	-0.07143
Ireland	-0.06	0.047	-1.2766	-0.159	0.069	**-2.30435**
Italy	0.04	0.029	1.37931	0.067	0.038	1.763158
Luxembourg	0.059	0.072	0.819444	0.116	0.074	1.567568
Netherlands	0.116	0.08	1.45	0.202	0.087	**2.321839**
Portugal	0	0.001	0	0.001	0.001	1
Spain	0.026	0.033	0.787879	0.031	0.049	0.632653
Sweden	0.064	0.055	1.163636	0.042	0.056	0.75
UK	-0.008	0.031	-0.25806	-0.044	0.035	-1.25714

			ICThome-ICTres			
Country	Half	standard error	t-statistic	Full	standard error	t-statistic
Austria	-0.005	0.008	-0.625	-0.002	0.009	-0.22222
Belgium	-0.004	0.007	-0.57143	-0.002	0.007	-0.28571
Denmark	-0.014	0.01	-1.4	-0.013	0.01	-1.3
Finland	0.013	0.016	0.8125	0.015	0.016	0.9375
France	0.008	0.022	0.363636	-0.003	0.024	-0.125
Germany	-0.006	0.024	-0.25	-0.014	0.025	-0.56
Greece	-0.009	0.009	-1	-0.001	0.006	-0.16667
Ireland	0.028	0.017	1.647059	0.024	0.017	1.411765
Italy	0.006	0.013	0.461538	-0.012	0.015	-0.8
Luxembourg	-0.046	0.059	-0.77966	-0.066	0.055	-1.2
Netherlands	-0.04	0.035	-1.14286	-0.028	0.035	-0.8
Portugal	-0.001	0.002	-0.5	0	0.003	0
Spain	0.006	0.017	0.352941	0.006	0.02	0.3
Sweden	-0.026	0.025	-1.04	-0.024	0.024	-1
UK	0.002	0.011	0.181818	-0.001	0.01	-0.1

			ICThome-ICTuse			
Country	Half	standard error	t-statistic	Full	standard error	t-statistic
Austria	0.019	0.057	0.333333	0.01	0.078	0.128205
Belgium	-0.075	0.039	-1.92308	-0.101	0.054	-1.87037
Denmark	-0.24	0.095	**-2.52632**	-0.215	0.115	-1.86957
Finland	-0.081	0.074	-1.09459	-0.011	0.099	-0.11111
France	-0.249	0.121	**-2.05785**	-0.271	0.185	-1.46486
Germany	0.028	0.062	0.451613	0.026	0.086	0.302326
Greece	0.091	0.047	1.93617	0.039	0.062	0.629032
Ireland	-0.085	0.058	-1.46552	-0.049	0.083	-0.59036
Italy	-0.081	0.057	-1.42105	-0.158	0.079	-2
Luxembourg	-0.12	0.08	-1.5	-0.2	0.109	-1.83486
Netherlands	0.359	0.155	**2.316129**	0.345	0.173	1.99422
Portugal	0.004	0.047	0.085106	-0.065	0.073	-0.89041
Spain	-0.152	0.053	**-2.86792**	-0.349	0.082	**-4.2561**
Sweden	0.048	0.086	0.55814	0.168	0.105	1.6
UK	-0.027	0.049	-0.55102	-0.005	0.06	-0.08333

		ICTuseca-socecoind	
Country	>2.5use	standard error	t-statistic
Austria	-0.003	0.004	-0.75
Belgium	-0.002	0.002	-1
Denmark	0.003	0.007	0.428571
Finland	0.001	0.005	0.2
France	-0.006	0.006	-1
Germany	0.002	0.003	0.666667
Greece	0.000	0.003	0
Ireland	-0.001	0.004	-0.25
Italy	0.001	0.003	0.333333
Luxembourg	-0.004	0.005	-0.8
Netherlands	0.001	0.005	0.2
Portugal	-0.001	0.003	-0.33333
Spain	-0.005	0.003	-1.66667
Sweden	0.007	0.005	1.4
UK	0.000	0.003	0

		ICTuseca-paredu	
Country	>2.5use	standard error	t-statistic
Austria	0.042	0.043	0.976744
Belgium	-0.013	0.023	-0.56522
Denmark	0.007	0.079	0.088608
Finland	-0.043	0.047	-0.91489
France	0.038	0.061	0.622951
Germany	0	0.029	0
Greece	-0.015	0.025	-0.6
Ireland	-0.046	0.031	-1.48387
Italy	-0.014	0.034	-0.41176
Luxembourg	-0.06	0.044	-1.36364
Netherlands	-0.009	0.04	-0.225
Portugal	-0.031	0.029	-1.06897
Spain	-0.013	0.025	-0.52
Sweden	-0.065	0.05	-1.3
UK	0.036	0.028	1.285714

		ICTuseca-ICThome	
Country	>2.5use	standard error	t-statistic
Austria	-0.165	0.118	-1.39831
Belgium	0.115	0.066	1.742424
Denmark	0.031	0.198	0.156566
Finland	0.067	0.14	0.478571
France	0.193	0.226	0.853982
Germany	0.002	0.097	0.020619
Greece	0.037	0.084	0.440476
Ireland	0.035	0.103	0.339806
Italy	0.116	0.089	1.303371
Luxembourg	0.324	0.149	**2.174497**
Netherlands	-0.013	0.144	-0.09028
Portugal	0.121	0.102	1.186275
Spain	0.257	0.104	**2.471154**
Sweden	-0.111	0.152	-0.73026
UK	-0.075	0.076	-0.98684

		ICTuseca-teares	
Country	>2.5use	standard error	t-statistic
Austria	-0.004	0.013	-0.30769
Belgium	0.003	0.011	0.272727
Denmark	-0.01	0.04	-0.25
Finland	0.019	0.032	0.59375
France	-0.019	0.025	-0.76
Germany	-0.013	0.022	-0.59091
Greece	0.025	0.011	**2.272727**
Ireland	0.043	0.034	1.264706
Italy	-0.018	0.026	-0.69231
Luxembourg	0.017	0.038	0.447368
Netherlands	0.024	0.039	0.615385
Portugal	0	0.001	0
Spain	-0.006	0.028	-0.21429
Sweden	0.028	0.02	1.4
UK	-0.025	0.021	-1.19048

		ICTuseca-ICTres	
Country	>2.5use	standard error	t-statistic
Austria	0.014	0.007	**2**
Belgium	-0.01	0.006	-1.66667
Denmark	0	0.021	0
Finland	-0.013	0.016	-0.8125
France	0.003	0.019	0.157895
Germany	0.015	0.017	0.882353
Greece	-0.016	0.01	-1.6
Ireland	0.014	0.014	1
Italy	0.022	0.014	1.571429
Luxembourg	-0.01	0.03	-0.33333
Netherlands	-0.001	0.013	-0.07692
Portugal	-0.003	0.002	-1.5
Spain	0.006	0.014	0.428571
Sweden	-0.007	0.004	-1.75
UK	0.016	0.007	**2.285714**

		socave-ICThome	
Country	>socave	standard error	t-statistic
Austria	0.122	0.079	1.544304
Belgium	-0.027	0.032	-0.84375
Denmark	-0.086	0.12	-0.71667
Finland	0.003	0.104	0.028846
France	-0.051	0.135	-0.37778
Germany	0.08	0.063	1.269841
Greece	-0.034	0.077	-0.44156
Ireland	-0.01	0.082	-0.12195
Italy	-0.011	0.066	-0.16667
Luxembourg	0.207	0.129	1.604651
Netherlands	-0.127	0.108	-1.17593
Portugal	0.124	0.077	1.61039
Spain	-0.059	0.078	-0.75641
Sweden	0.089	0.097	0.917526
UK	0.017	0.063	0.269841

		socave-ICTres	
Country	>socave	standard error	t-statistic
Austria	0	0.005	0
Belgium	0.004	0.004	1
Denmark	0.001	0.002	0.5
Finland	0.015	0.008	1.875
France	0.015	0.014	1.071429
Germany	-0.017	0.014	-1.21429
Greece	-0.011	0.008	-1.375
Ireland	0.017	0.012	1.416667
Italy	0.011	0.01	1.1
Luxembourg	-0.048	0.018	**-2.66667**
Netherlands	0.008	0.012	0.666667
Portugal	0.001	0.002	0.5
Spain	0.004	0.014	0.285714
Sweden	-0.006	0.004	-1.5
UK	0.017	0.006	**2.833333**

		socave-ICTuse	
Country	>socave	standard error	t-statistic
Austria	-0.043	0.032	-1.34375
Belgium	-0.005	0.018	-0.27778
Denmark	0.049	0.047	1.042553
Finland	-0.032	0.047	-0.68085
France	0.049	0.086	0.569767
Germany	-0.014	0.038	-0.36842
Greece	-0.029	0.03	-0.96667
Ireland	0.01	0.043	0.232558
Italy	0.004	0.036	0.111111
Luxembourg	0.045	0.054	0.833333
Netherlands	0.022	0.049	0.44898
Portugal	-0.045	0.032	-1.40625
Spain	0.032	0.037	0.864865
Sweden	-0.01	0.044	-0.22727
UK	-0.039	0.03	-1.3

Chapter 9

Implications

This project set out to answer the question of how to conceptualise and operationalise human investment in the era of the New Economy. In answering this question, a number of implications have arisen from this project. These can be divided into the following categories:

- Methodological implications
- Implications for the European Statistical System/EU statistical indicators of the New Economy
- Implications for the Lisbon process and OMC

It is the objective of this chapter to discuss these sets of implications arising from the work undertaken in this project. In the following each of the three areas will be dealt with in turn.

9.1 Methodological implications

The objective of this project was to provide an answer to how to conceptualise and operationalise human investment in the era of the New Economy. In answering this research question, the project took as its point of departure the ongoing debate on human investment, capital and its economic role. The answer that has been developed, presented and discussed in preceding chapters has a number of implications for this debate. This section will discuss these implications in greater depth.

In order to answer the research question it was first necessary to establish the nature of human investment provision in the New Economy. Accordingly, in chapter 3 a conceptual framework of the nature of human investment provision in the New Economy was developed. The foundation on which the development of the conceptual framework

was build, was a review of current and past discussions in the human investment literature. Notably, the thesis discussed the criticism of the neo-classical approach to the analysis of human investment and its failure to adequately take account of how processes of human investment are inextricably linked to and shaped by the wider socio-economic fabric. In particular, it was noted that much of the neo-classical analysis of human investment has focussed on formal education, whilst neglecting other aspects of human investment provision. However, using formal education as a proxy of human investment is only useful for industrialised countries during the latter part of the twentieth century, because it is only for these particular countries and during this period that the predominant form of human investment has been provided through formalised institutions of education. Illich (1971) argues that during previous periods, and in other countries, the primary form of human investment may not be formalised, but take place at work or in the home. Furthermore, more recent literature, such as Estevez-Abe et al (2001), has examined in more detail how differences in political economy shape different types of human investment provision. In light of these discussions, the project argued that there is a need to re-conceptualise human investment such as to take account of the effects on human investment provision resulting from the wider socio-economic changes associated with the New Economy.

The analysis highlighted changes occurring in the demand for and supply of human investment. On the demand side, the changes to human investment provision can be summarised as the increasing demand for human investment, and need to invest throughout an individual's lifetime. The skill-biased and dynamic nature of the New Economy creates a greater need for human investment, and requires the continuous acquisition and upgrading of skills by individuals throughout their working lives. However, the New Economy also introduces a number of new opportunities for meeting the demand for human investment. It is thus increasingly recognised that ICT can play a major role in human investment in a number of different areas of life. At the political level, these changes have been captured in the notion of lifelong learning (European Commission, *A Memorandum on Lifelong Learning*). Central to this new paradigm of human investment is the centrality of the individual learner, rather than the institution of

education. Accordingly, human investment should be understood as processes of learning that take place in a number of areas of life, including the workplace and home, throughout life, rather than a period in a person's life prior to entering the labour market. As noted in *A Memorandum on Lifelong Learning* and a number of academic publications, such as Tuijnman (2002), such a paradigmatic shift in our understanding of human investment introduces a number of new facets to human investment provision, notably the added importance of less formal means of learning. These new facets were captured and structured in a conceptual framework of human investment provision in the era of the New Economy in chapter 3 of this thesis. This conceptual framework introduces a complex matrix of human investment provision. In particular, the analysis introduced a more multi-dimensional framework with several education environments and stakeholders. The more complex conceptual framework of human investment presented in chapters 3 and 4 has a number of methodological implications for how human investment is operationalised.

Firstly, and most obviously, an operationalisation of human investment needs to recognise the different periods and areas of life in which learning can take place and provide suitable measures of the core variables specified in chapter 4. It is therefore necessary to go beyond measurements limited to formal education, and recognise that several areas of life not usually associated with human investment can become places of learning. However, it is important to stress that different areas of life require different characteristics for successful learning. A related methodological implication of the analysis presented in this project is therefore that each area of life must be operationalised as education environments in their own right, and not to the extent that they resemble formal education environments. For example, adult learning in the workplace is of a different kind than the learning processes for pupils in formal education, and needs to be operationalised as such. In addition, it is important to recognise that the activities of several actors are of relevance. For example, the operationalisation of human investment in the non-formal education environment needs to recognise that human investment can be facilitated through activities by both employers and employees.

Secondly, methodological challenges associated with the operationalisation of human investment arise from the recognition that the existence of a multitude of opportunities for learning in different education environments means that different areas of life may take on different roles in the overall framework of human investment in different countries. Such differences between countries may be shaped by variations in the wider institutional framework and political economy. Any attempt to measure and benchmark human investment for countries within the European Union needs to recognise such structural differences, and provide suitable measures of the systemic variables specified in chapter 4.

This includes the methodological implication emerging from the recognition that in a multi-dimensional framework of human investment provision, the processes of human investment in different areas of life interact and shape each other. Systemic and institutional differences between countries may thus manifest themselves in different types of interactions between the core variables of each education environment and level of aggregation. An operationalisation of human investment can therefore not limit itself to measuring human investment within each isolated area of life. We need to know something about how processes of human investment in different education environments interact during different periods of an individual's lifetime. In particular, it is necessary to ascertain how the introduction of ICT in different environments interact with each other and reshape the overall framework of human investment provision. Such interactions and processes of reshaping are unlikely to be uniform across countries and therefore require indicators in their own right.

With different levels of expectation and success, this project has attempted to deal with the two sets of methodological challenges outlined above. The indicators in chapter 6 represent the outcome of the attempt to meet the first set of challenges, while the analysis and indicators presented in chapter 7 is the outcome of an attempt to meet the latter set of challenges. However, in many ways, the methodological work done in this thesis raises more questions than it answers. There are thus ample opportunities for further research to be undertaken in light of the analysis presented here.

Furthermore, while it has not been the objective of this project to measure the economic role of human investment, the work undertaken in this project has methodological implications for the empirical estimation of the contribution of human capital investment to economic growth, as reviewed in chapter 2. Notably, the multi-dimensionality of human investment in the era of lifelong learning raises a number of questions as to the appropriateness of the methods currently used.

In what follows, the various methodological implications will be explored in greater depth. This will include a discussion of the project's efforts to meet the methodological implications associated with the operationalisation of human investment, and highlight some of the key limitations of the analysis presented, suggesting areas requiring further research.

9.1.1 Measuring the core variables for the relevant education environments and stakeholders

The recognition of the areas of life in which human investment can take place, was achieved by conducting a specification of variables for each of the relevant education environments. The specification of variables was based on the paradigm of lifelong learning with the individual learner at center-stage. In contrast, the emphasis in previous efforts was on the development of comparable indicators of people's participation in and resources devoted to institutions of formal education. While this in itself is a complex task, as has been noted in work such as Fuente and Doménech (2000) reviewed in chapter 2 of this thesis, the operationalisation of human investment in this project has a very different conceptual starting point.

Furthermore, it was recognised that the learning taking place in any given education environment is not only dependent upon the efforts of the individual learner, but requires efforts by all relevant stakeholders. Accordingly, the specification of variables took account of the efforts required by different actors at different levels of aggregation. For

period 1 this amounted to a specification of variables at the micro-level of the individual learner for the relevant education environments; a specification of variables at the meso-level of the formal education environment, referring to activities of the formal education environment at the level of the organisation; a specification of variables at the macro-level of the formal education environment, referring to activities or efforts for formal education at the level of the state or society as a whole.

For period 2, the specification of variables took account of activities by the individual learner in all the relevant education environments at the micro-level; at the meso-level of period 2, the specification of variables covered activities and features at the level of the organisation and employer in the non-formal education environment; at the macro-level variables were specified for the expenditure and efforts by the state on formal adult education and training.

These variables were subsequently translated into sets of indicators, based on a stocktaking of available data, and structured in scorecards and composite indicators resonating with the conceptual framework.

Scorecards

Having developed a conceptual framework that acknowledged the increasing multi-dimensionality of human investment provision and centrality of the individual learner in the paradigm of lifelong learning, the project proceeded to operationalise the conceptual framework. In so doing, it was recognised that the method of operationalisation had to acknowledge the existence of the different dimensions and several stakeholders involved in the processes of human investment. Accordingly, the decision was to develop scorecards of statistical indicators structured in accordance with the conceptual framework. The objective of introducing scorecards was to demonstrate to policy makers and other stakeholders the strong and weak areas of human investment provision, and in so doing serve as a platform for improvements.

The construction and use of scorecards of human investment introduces a method for estimating human investment not previously associated with the operationalisation of human investment. Rather, the idea to construct scorecards stems from the growing literature on knowledge management and efforts to account for intangible assets in

commercial organisations, such as the Skandia Navigator (Edvinsson and Malone, 1997) and the Balanced Scorecard (Kaplan and Norton, 1996). The use of scorecards in that context has been due to the recognition that there are a number of intangible dimensions of an organisation, beyond the traditional financial and physical assets, of importance to a firm's success. Similarly, this project has argued that the emergence of a more multi-dimensional human investment provision makes the scorecards a useful method for taking account of dimensions beyond the formal education environment.

Composite indicators

In light of the multitude of indicators contained in the scorecards, and to allow some degree of parsimony, a set of composite indicators were developed. These were intended to summarise the information contained in the scorecards and allow for an overview of each country's performance in the various dimensions of the conceptual framework. Whilst all these efforts attempted to specify a set of variables and indicators that would allow for a comprehensive operationalisation of human investment, the efforts are subject to some limitations, suggesting areas for further work.

The construction of scorecards was not without methodological reservations. In as so far as the objective of the scorecards is to promote awareness and understanding of human investment provision in the European Union, it could be argued that the scorecards only provide an inadequate picture of the more complex processes of human investment provision. The structure of the scorecards requires rather crude distinctions between the activities of various actors in different education environments that may not be entirely warranted. To some extent, the human investment scorecards developed in this project thus face similar problems to those encountered in the knowledge management literature. As noted in this literature, when using scorecards "defining the right measures is not sufficient. Rather, it is necessary to identify the *systems* that relate to these measures and how they interact" (Zingales, Rourke and Orssatto, 2000:11). While later parts of the project attempts to address some of these concerns, it could be argued that we need to consider in greater depth whether it is possible to develop indicators of the system of human investment provision, rather than measurements of various human investment

activities by individual actors. Such considerations may include data collected from other sources than surveys and financial records, which could say something about the manner in which the various activities and resources contribute to human investment provision. This remains an area of interest for future research.

Furthermore, the efforts to develop the scorecards involved the use of data not previously used for the measurement of human investment. Notably, the operationalisation of period 2 of the human investment framework included the use of data on features of the places of employment. In so doing, this project has extended the scope of the nature of the data used for measuring human investment. However, the stocktaking of data sources for the construction of indicators of human investment conducted in chapter 5 also revealed considerable gaps in the available data.

At the micro-level of period 1, the operationalisation of the informal education environment leaves a lot of areas uncovered. While the indicators provide some information about the availability and use of ICT by pupils in the home, it would be useful to know more about the features of the informal education environment shaping human investment processes for the pupil. Indeed, a critical weakness in prevailing operationalisations of period 1 is the lack of indicators for the informal education environment. As noted by the OECD (1998:41), informal learning represents a considerable methodological difficulty because "Family investment in human capital can be hard to separate from the high overall level of spending on children". However, if ICT facilitates new learning opportunities in both the informal and formal education environments, and possible connections between the two, we need a better understanding of the role of the informal education environment and how best to operationalise it. Merely measuring the availability and use of ICT in the household seems inadequate. In light of the discussion in chapter 4 of the transformations to the informal education environment, it may be useful to develop better indicators of the factors from the informal education environment contributing to human investment.

In addition, there are aspects of the introduction of ICT in the formal education environment which require further considerations. It has been argued that the successful utilisation of ICT in the formal education environment requires changes in pedagogy and education approach in schools. Arguably, by using indicators of training of staff in the use of ICT for education purposes, the indicators presented for the meso-level of period 1 is a reasonable attempt to capture such changes. However, it would be of interest to be able to track such changes in the formal education environment with indicators capturing differences in pedagogy arising with the introduction and utilisation of ICT.

The key operational weaknesses of the efforts in this project to measure the various dimensions of the human investment framework are related to the operationalisation of period 2. Notably, the measurement of learning in the workplace, as opposed to training provided or financed by the employer, represented a major difficulty. One of the key methodological problems encountered was that human investment in the non-formal and informal education environments has mainly been measured as the extent to which features in these environments were resembling formal education. Hence, the measurement of human investment provided in the workplace focused on the extent to which training courses were made available, rather than how the workplace was an environment facilitating learning. In light of the conceptual discussion in chapters 3 and 4, this provides us only with a very limited picture of the human investment processes taking place in the non-formal education environment. This represents a serious problem for a satisfactory operationalisation of human investment.

The critical challenge is to measure how the context of and activities in the workplace contribute to learning. The project extended its stocktaking of data sources beyond the traditional sets of human investment indicators, to include employment and business data on the nature of organisations and the workplace. It is, however, debatable whether the available data provides us with satisfactory estimates of the role of the workplace in human investment provision. At the meso-level critical questions remain unanswered as to how best to measure the existence of learning organisations. Indeed, the extent to which the existence of learning organisations can meaningfully be operationalised by means of statistical indicators remains open to question. It has been argued that the

learning organisation is characterised by a culture allowing all stakeholders to participate in the processes of socially constructing meaning in relation to the organisation of work and processes of change. If so, a satisfactory operationalisation should capture this culture. It is debatable whether quantitative indicators are appropriate tools for proxying such social processes. However, this project has argued that, as a minimum, certain critical features of learning organisations can be proxied by indicators measuring the extent to which employees feel they participate in shaping the organisation in which they work. Notwithstanding these efforts, more work in this area is called for. As Tuijnman (2002) argues, "Non-formal learning at work and continuing vocational training sponsored by firms and public employers both represent large learning sectors about which few official statistics have been collected to date" (Tuijnman, 2002:12). As we become more aware of the particularities of learning in the non-formal education environment, as evidenced by the growing literature on adult-learning and the learning organisation, the collection of data needs to adapt accordingly. This is one of the key methodological challenges ahead, if we are to gain a better understanding of human investment in the era of the New Economy.

The difficulties discussed above also apply to the micro-level of the non-formal education environment in period 2. If the workplace is potentially becoming an important part of human investment provision, we need better indicators of the activities by individual employees in the workplace which facilitate learning. This project used indicators measuring the extent to which employees felt they were learning in the workplace, but indicators of actual learning activities in the workplace would be a useful addition. This would include indicators measuring the use of ICT, which could differentiate between activities that are conducive for learning and those that are not. The mere use of ICT does not guarantee that the technology is used for activities associated with learning.

Similarly, the operationalisation of the informal education environment in period 2 focuses heavily on the availability and use of ICT. In addition, there are indicators of self-directed learning. It is debatable whether these indicators are satisfactory proxies of the features of the informal education environment contributing to human investment.

At the macro-level of period 2, the indicator in chapter 6 only accounts for public expenditure on adult education and training. However, public funding and support of human investment in period 2 can take a number of different forms. For example, tax and subsidies for employers and individual learners to undertake learning activities may be increasingly used in the future. Alternatively, policies could be introduced which regulated for greater human investment efforts in the non-formal education environment. This makes it more difficult to differentiate between expenditure at the relevant levels of aggregation in period 2. Ideally, the statistical indicators should take account of all the different ways in which human investment can be funded and supported. This will be an area requiring further work in the future.

Furthermore, there is no satisfactory data available on the changes to the labour market required to facilitate learning organisations and less formalised parts of the human investment provision in period 2. This is partly because little is known about how the labour market can best accommodate the paradigmatic shift to lifelong learning. Consequently, much more conceptual and methodological work is required in this area.

Finally, the use of composite indicators is debatable, in light of sub-indicators possibly taking on different roles in different countries. Indeed, in as so far as the use of indicators and benchmarking is to respect the diversity of human investment provision in the European Union, the use of composite indicators may prove unsuitable. As Room et al (2004) argue, "the construction of a single composite index would seem to go against our argument, that new economy benchmarking indicators should enable policy-makers to assess a variety of alternative futures, rather than simply monitoring their progress along a single trajectory of development" (Room et al, 2004:195).

These weaknesses have to be weighed against the benefits of clarity and parsimony achieved by constructing composite indicators. This project has argued that the use of composite indicators can be a very powerful tool for achieving an overall picture of human investment provision, but should be complemented with a comprehensive sensitivity analysis that can alert us to areas where national differences in the relative

importance of sub-indicators may be significant. It was also argued that the sensitivity of the composite indicators developed in this project suggests that the construction of appropriate composite indicators may require further consideration of the weights attached to sub-indicators. In particular, it was suggested that the use of a Delphi-method in which the consideration of experts were taken into account may be useful for this purpose.

9.1.2 Measuring the systemic variables of the human investment framework

A successful operationalisation of the multi-dimensional framework of human investment needs to do more than merely measure the different dimensions. It needs to say something about how the different dimensions stand in relation to each other. The education environments do not exist in isolation but within the wider human investment framework. Moreover, this human investment framework exists within a wider institutional framework and political economy which in turn will shape the nature of the human investment framework. Examining each dimension in isolation may be inappropriate, and lead to misguided conclusions for policy. Accordingly, it is necessary to establish the role of the different dimensions in shaping human investment. This entails more than merely developing indicators for each of the education environments, as was done in chapter 6. For example, depending on the nature of overall human investment provision and how ICT is being used, the availability of ICT in the informal education environment may be more important than the availability of ICT in the formal education environment. In other words, how do we compare a country rich in ICT in the formal education environment and poor in ICT in the informal education environment, with a country poor in ICT in the formal education environment but rich in ICT in the informal education environment? Should the policy response be to increase the ICT availability in the environment in which the country is relatively poor? The answer surely is that this should depend on where the marginal gains to human investment from increasing ICT availability is highest. If ICT availability in the informal education environment is more important for human investment outcomes than ICT availability in the formal education environment, the focus should surely first and foremost be on improving ICT availability

in the informal education environment. However, the marginal gains from improving ICT availability in the different environments cannot be expected to be uniform across countries in the European Union. The importance of features in the various educational environments will be shaped by the nature of the human investment framework and wider institutional framework, of which the indicators developed in chapter 6 say very little or nothing about. Accordingly, a significant methodological challenge is to establish the differences in the wider human investment framework between countries, and in particular how these differences manifest themselves in differences in marginal benefit to human investment outcomes from the features measured by the indicators in chapter 6.
A further, and related, methodological implication of the multi-dimensional human investment framework, is the difficulty of operationalising the interactions of features within and between dimensions of human investment. The shift to a more multi-dimensional human investment framework requires us to examine how the different dimensions interact and shape each other. With regard to the introduction of ICT as a learning tool, the issue of interactions has further methodological implications. ICT does not exist as a learning tool in isolation. Rather, the nature of the use of ICT will be shaped by and reshape the characteristics of the education environment in which it is used. Accordingly, to assess the introduction of ICT as a learning tool, it is necessary to measure how ICT interacts with other features of the education environments, and how the availability and use of ICT in different education environments interact with each other.

In chapter 7, this project proposed a statistical analysis which would provide indicators meeting these methodological challenges. The analysis is a multi-variate multi-level regression analysis which provides us with coefficients estimating the significance of various features, notably ICT, of the formal and informal education environments in period 1. These coefficients are proxies of the relative importance of the different features of the formal and informal education environments. In addition, the analysis included a number of interaction terms which estimated the impact of ICT on the relevance of other features of the education environments. It is suggested that these interaction terms serve as proxies for the reshaping of period 1 of the wider human investment framework

resulting from the introduction of ICT as a learning tool. Accordingly, the analysis in chapter 7 provides a methodology for constructing more sophisticated indicators for the operationalisation of the more complex transformations of human investment provision associated with the paradigmatic shift to lifelong learning and introduction of ICT as a learning tool.

Nevertheless, using a statistical analysis such as the one proposed here, for the development of indicators of human investment cannot be embarked on without reservations. Firstly, a statistical analysis can provide insights into relationships between clearly defined variables. This is not necessarily the same as illuminating lines of causality which are subject to a number of complex processes within the framework of human investment provision. As was noted in the previous chapter, the coefficient for teacher resources in some of the countries is negative. One could easily be tempted to conclude that greater teacher resources contribute negatively to human investment outcomes. However, this contradicts our more intuitive understanding of education provision. Accordingly, it may be the case that teacher resources are allocated in such a manner that less well performing pupils have more teacher resources made available to them. This illustrates the precariousness of the method used and alerts us to the dangers of drawing too strong conclusions from the findings.
Notwithstanding these reservations, the statistical analysis gives a preliminary picture of the features of the educational environments in period 1 that contribute to human investment. This picture can be complemented with other methods of exploring the processes of human investment, such as the Delphi method discussed above.

In addition, it was noted that the statistical analysis in chapter 7 operates under a number of constraints, and that further work is required in order to develop a better operationalisation of this particular feature of human investment. Firstly, the analysis requires the specification of clearly measurable outcomes. The analysis in chapter 7 makes use of standardised test scores in reading and mathematics obtained from the PISA study conducted by the OECD. However, the outcome measures from the PISA study test a set of abilities, some of which may reflect natural differences. If there had been

longitudinal data available, it would have been possible to examine the importance of various features in adding abilities to students, and thus get a better measure of the value added by human investment provision in period 1. For example, it would have been useful to include an explanatory variable with test scores for each student prior to commencing participation in formal education. This would perhaps also lead to more significant results than those achieved in the analysis attempted in this project.

In addition, the measures from the PISA study only capture a very narrow range of skills provided by the education system. It could be argued that the test scores capture too narrow a range of skills. For example, it has been argued that the emphasis on literacy and numeracy is inappropriate in an era where a number of softer skills are required. Developing better measures of education outcomes is thus essential, not just as an objective in itself, but for further analysis of how different aspects of the human investment framework contribute to education outcomes. However, this requires a consensus on what is to be achieved from the human investment processes of period 1. This is no simple task. These issues are related to a wider discussion currently taking place (Atkinson, 2004 and Coulombe et al 2004) on the methodological challenge of measuring outcomes and value added in education. It is difficult to establish what constitutes outcomes from education systems and even more so to find suitable measures of it.

Moreover, a key difficulty with the analysis in chapter 7 is that it is only applicable to period 1. The use of a similar quantitative analysis for period 2 is limited by a number of constraints. The measurement of outcomes from adult learning has been attempted by the OECD in the International Adult Literacy Survey (IALS) and Adult Literacy and Life-Skills Survey (ALL). The surveys measure basic literacy and numeracy levels for adults in OECD countries. However, it is debatable whether these surveys provide satisfactory proxies of the outcomes from the adult learning taking place in period 2 of the human investment framework. The adult learning literature argues that the outcomes of learning by adults may be less easily definable and may be more difficult to measure. Such learning has often been contextualised in relation to the particular work of the individual

learner. While formal education follows curricula with reasonably clear objectives, it is far more difficult, if not impossible, to determine a common set of outcomes for the human investment taking place in period 2. However, in response to these challenges, it may be more appropriate to use self-assessment by the learner, or to measure changes in performance or work satisfaction by the employee in the workplace. This is reflected in recent national efforts to measure adult learning, such as the UK Adult Learning Survey (2002) and the Finnish Adult Education Survey (2000). In contrast to the IALS and ALL of the OECD, the outcomes in these national surveys are self-assessed by the learner, and set in relation to the work situation of the individual undertaking the learning activity. It may therefore be possible to meet the second set of methodological challenges and conduct a statistical analysis for period 2 when internationally comparable data becomes available.

However, it is also important to note the limitations of quantitative indicators for measuring the complex processes of transformation of human investment set in motion by the introduction of ICT as a learning tool. Whilst this project has suggested a methodology by which such indicators may be developed and used for benchmarking, the analysis has been conducted with only modest expectations, given the complexities which are being operationalised. Complementing such indicators with analysis of a qualitative nature may provide useful insights into the changing nature of human investment resulting from the emergence of the New Economy. Such analysis could illuminate the changes taking place in all three education environments and during both periods of the human investment framework.

These difficulties are further accentuated by virtue of the relative role of different dimensions of the human investment framework and the interaction between features of the various education environments being subject to change. The differences in relative importance of various education environments and interactions between environments are not merely geographically contingent but also change over time. SIBIS (2003) notes that times of rapid technological development are likely to see a relatively increasing role for the type of learning associated with the non-formal and informal education environments.

As much as the role of various dimensions of the human investment framework is different between countries at any given point in time, as the findings of this project suggests is the case, so the processes of change in the relative importance cannot be assumed to be uniform across countries. As argued by Room et al (2004), the operationalisation of such processes of change "remains an important area for future work" (Room et al 2004:121).

Notwithstanding the great methodological challenges and limitations to the operationalisation presented in this project, it is also important to emphasise that this does not mean we can't measure anything satisfactory or introduce appropriate statistical indicators for benchmarking. Rather, the complexities of human investment provision require us to consider carefully the methodological difficulties and attempt to overcome them. Indeed, this project is such an attempt. However, the work undertaken in this project should preferably be complemented with further methodological work, some of which may be of a more qualitative nature.

9.1.3 Measuring human investment and its economic role

It was argued in the previous chapter that different dimensions of the human investment framework may be more suitable for different institutional frameworks and political economies. This brings into question the wisdom of using cross-country regression analysis as a method of estimating the role of human investment and capital for economic growth. Indeed, the mixed results found from regression analysis, on the contribution of human capital and investment to economic growth, referred to in chapter 2, may be explained by the very simplistic conceptualisation and operationalisation of human investment and capital. Indeed, as was noted in chapter 2, the weakness of human capital and investment indicators for economic analysis has been an area of increasing concern and debate in the economic growth literature (Fuente and Domenech, 2000). This has inspired a number of efforts to take account of differences in processes of human investment provision between countries. In particular, "As education systems vary among countries, it made sense to try and normalize the data sets used in the estimations in order

to take quality into account and also to minimize measurement errors related to data anomalies" (Coulombe et al, 2004:15). Accordingly, recent efforts have been undertaken to develop indicators of human capital and investment based on measures of the quality of individuals leaving education and in the labour force. Some of the most notable examples of these attempts are those of Hanushek and Kimko (2000), Barro (2001) and Coulombe et al (2004). All of these attempts make use of test scores obtained from students participating in international assessment of either or all of science, mathematics and reading. However, in light of the very limited measure of quality and outcomes achieved from such international assessments, as discussed above, the use of such indicators may not be appropriate. Indeed, given the nature of human investment provision in the era of lifelong learning, with various education environments conferring different types of skills, the inadequacy of test scores as indicators of human investment becomes even greater. If human investment takes on different forms in different education environments, the simplistic use of a single measure of human capital and investment based on formal education is likely to lead to significantly distorted results. The failure to take account of the various ways in which human investment is taking place, and the apparent fact that there is not necessarily a correlation between formal education and these other dimensions of human investment provision, suggest that the cross-country regression analysis of human capital investment and productivity growth referred to in chapter 2 are methodologically questionable.

Rather, a more sophisticated analysis of human investment and productivity growth is required. It was argued in the previous chapter that different economies may shape different types of human investment provision. In light of the varieties of capitalism approach developed by Hall and Soskice (2001), which suggests that differences in institutional frameworks give rise to comparative advantages in different sectors, it may be that each of these economic structures and concomitant configurations of human investment provision may be suitable for different sectors. These sectors may on turn have different skill requirements. Indeed, the application and utilisation of ICT in different sectors and institutional settings may create different types and degrees of skill-bias. Interestingly, it has been noted by Acemoglu (2003) that countries are displaying

different skill-biases as a result of their development and utilisation of ICT as a new technology in economic processes. Different institutional frameworks may give rise to different New Economies with concomitant differences in skill-bias and skill requirements, which in turn lead to different configurations of lifelong learning and human investment provision. Accordingly, it may be more appropriate to conduct analysis of human investment and productivity at the sectoral level. Contrasting performance at the sectoral level across countries with different types of human investment may show how different approaches to human investment provision are more suitable to different sectors. The work undertaken in this project on human investment thus has a number of implications for our understanding and operationalisation of the role of human capital and investment in the wider economy and society, an area of empirical research which has been troubled with immense methodological difficulties. It would be of interest to pursue these questions further in future research.

In sum, trying to equate very varied human investment frameworks in overly simplistic indicators may well be inappropriate in the context of the New Economy. Indeed, it is evident from the findings in this project that trying to oversimplify the operationalisation of human investment into a single or few indicators will provide greatly misleading results in the era of lifelong learning. Even the composite indicators constructed in this project, which attempted to simplify the vast amount of information presented in the scorecards, displayed problems of sensitivity which may well have been due to different areas of human investment not being of equal political significance in all member states. Hence, while this project takes as its starting point that sensibly constructed indicators may be of great use to policymakers in the area of human investment, the complexity of human investment provision has a number of methodological implications which require due consideration. It is debatable whether indicators hitherto used for benchmarking and comparison satisfactorily meet these methodological challenges. In response to these weaknesses, this project has suggested a number of indicators, which have not previously been used for the purposes of benchmarking human investment. These new indicators reveal considerable differences between countries in dimensions of human investment provision previously uncovered in comparisons of human investment in the European

Union. The suggested indicators are, however, only a first attempt at capturing new aspects of human investment, and more methodological work is required.

9.2 Implications for the European Statistical System/EU statistical indicators of the New Economy

The methods for operationalising human investment in the era of the New Economy put forward in this project attempt to meet a number of methodological challenges. This was done in a wider context of the NESIS project, which has as its main objectives to ascertain the policy needs for indicators on the new information economy and contribute conceptually and statistically to the appraisal of existing EU benchmarking indicators. While it is not the objective of the NESIS project to produce a complete statistical information system for the New Economy, "its principal aims are to disseminate awareness of the need for the ESS [European Statistical System] to respond to the challenges posed by the dynamics of the new information economy" (NESIS Project Summary:3). The work presented in this thesis is thus part of a wider discussion on the appropriateness of available indicators for measuring and benchmarking the New Economy for the purposes of the OMC and Lisbon Strategy, and what can be done to improve the statistical information system. For human investment, much of the discussion has focused on the multitude of challenges associated with the measurement of changes taking place among providers of education and training services as a result of the introduction of ICT as a new learning tool (see Room et al, 2004). Notably, the emphasis has been on developing appropriate indicators measuring the availability and use of ICT in schools and the emergence of e-learning. A further critical feature of the discussion has been the challenges of measuring the pedagogical change and student-centred learning said to be associated with the introduction of ICT in schools (SIBIS, 2001).

Similar issues emerge from the analysis in this thesis. However, the conceptual and operational efforts presented here have some wider implications for the development and use of statistical indicators of human investment. These implications arise from the difficulties encountered when operationalising the conceptual framework of human

investment with the available data. It is therefore of interest to briefly reflect on the key implications of the work conducted in this thesis for the wider discussion on establishing an appropriate statistical information system for the New Economy.

The development of a statistical information system informing policy makers and other stakeholders of developments in the New Economy needs further collection of human investment data, such as to include new aspects of all relevant education environments. There is a great lack of data for the non-formal and informal education environments. The lack of data on work-based learning is an issue that has been repeatedly highlighted in the discussion of indicators on human investment (Room et al, 2004). However, the conceptual analysis in this thesis shows that the data collected for the non-formal and informal education environments need to recognise the particular nature of learning in these environments. A particular weakness of the currently available data, and many of the recommendations for its improvement, is the emphasis on more formalised training and education related to work, rather than measurements of how activities in the non-formal and informal education environments contribute to learning. Moreover, the implications of adult theories of learning for the measurement of human investment have yet to be fully incorporated into the discussions and efforts to develop an appropriate statistical information system. Consequently, there is an urgent need for more methodological work and data on how activities in the workplace contribute to learning by adults. This should include more concerted efforts to develop statistical measures of the prevalence of learning organisations.

A related issue is the need for further conceptual and methodological work on the role of the labour market in shaping opportunities for lifelong learning. Few conceptual and methodological considerations have been made of how lifelong learning raises a number of challenges to the structure of the labour market. Hence, at the macro-level of period 2 it was noted that no satisfactory data is available on how features of the labour market impede or promote learning opportunities in the non-formal and informal education environments. More work in this area is urgently needed, in order to provide policy

makers and other stakeholders with information of the potential obstacles and opportunities for enhancing human investment provision.

In addition, it would be useful to have better outcome measures of human investment that take account of the different skills conferred by the different education environments. This includes data on learning outcomes in period 2 of the conceptual framework. Several contributions to the debate on improving the available statistical data suggest that outcome measures of human investment is an area of significant weakness (Room et al, 2004 and Coulombe et al, 2004). As was noted in chapter 2, the work of Fuente and Doménech (2000) and Coulombe et al (2004) highlights the current difficulties in developing comparable outcome indicators. However, the emphasis in this project placed on the new opportunities for learning in the non-formal and informal education environments, and the context specific nature of the outcomes from such learning, raises a number of questions as to the appropriateness of the methods recommended and used in this body of work. Notably, the efforts of Coulombe et al (2004) to use standardised test scores from the OECD's IALS data set as a measure of human investment outcomes provides indicators of only limited conceptual resonance. Rather, there is a pressing need for more comparable data on the context specific outcomes of learning at work or in the home. Moreover, such appropriate outcome measures would, with the complementing data, also allow for more longitudinal analysis of the factors contributing to human investment outcomes as individuals progress through the framework of lifelong learning.

In sum, it has been difficult to find data useful for a comprehensive operationalisation of the new features of human investment provision. Accordingly, the European Statistical System must expand and adapt its development of indicators to take account of the transformations of human investment associated with the New Economy and lifelong learning.

9.3 Implications for the Lisbon Strategy and the OMC

The starting point and policy context of this project is the Lisbon Strategy and its ambitious objective for the European Union to become the most dynamic and competitive

knowledge-based economic area in the world with social inclusion (Presidency Conclusions, 2000). A critical element of the strategy to achieve this objective was a substantial increase in human investment by all member states. The emphasis on skills, education and training has been echoed in a number of other EU documents such as *Towards a European Research Area* (European Commission, 2000) and *The New Knowledge Economy in Europe – A Strategy for International Competitiveness and Social Cohesion* (Rodrigues et al, 2002). It is thus argued that the success of knowledge-based economies is based on ensuring a highly skilled workforce. Moreover, it is argued that the centrality of skills in the New Economy makes human investment an important policy tool for reconciling economic and social objectives. Human investment will increase economic prosperity whilst ensuring a socially cohesive society. It has not been the objective of this project to question these arguments, and from the analysis conducted, no conclusions can be drawn as to the wisdom of the Lisbon Strategy or the emphasis placed on human investment. However, it is important to note that the arguments underpinning the Lisbon Strategy and the pursuit of human investment to meet economic and social objectives have all been contested (e.g. Brown and Lauder, 2003). Rather, it is the argument of this project, that a satisfactory analysis of such questions requires a better understanding and operationalisation of human investment. Indeed, as noted in chapter 2 a critical weakness in the discussion of the role of human investment in achieving economic objectives has been the very simplistic understanding and measurement of human investment. This is particularly the case in light of the technological and socio-economic transformations associated with the emergence of the New Economy. Accordingly, this project developed a conceptual framework for understanding and a methodology for operationalising human investment in the era of the New Economy. The analysis conducted in this project suggests that the realisation of lifelong learning requires a number of efforts by policymakers and other stakeholders involved. It is the objective of this section to outline the implications of the analysis conducted in this thesis for the Lisbon Strategy and the Open Method of Coordination. In what follows, the implications for human investment policy in the context of the Lisbon Strategy will be analysed. In addition, the implications for using indicators as a policy tool in the area of human investment will be examined. This will include considerations

of implications for the implementation and use of the Open Method of Coordination more generally.

The conceptual framework developed in chapter 3 and specification of variables in chapter 4 highlights a number of dimensions to human investment that require consideration by policymakers. However, the framework also presents us with some major methodological challenges associated with the operationalisation of human investment, as discussed in section 9.1 of this chapter. The conceptual framework and efforts to meet each of these methodological challenges have a number of policy implications. This is only to be expected, since the premise on which this project is undertaken is that the conceptual framework and indicators not only inform us about the current state of affairs but also are to be used as tools for pinpointing areas for policy intervention. Accordingly, many of the implications for human investment policy arising from the analysis in this project follow the two sets of methodological challenges discussed previously in this chapter.

Firstly, in light of the analysis presented in this project it is important that policies for human investment are not solely focused on formal education, but recognise the need to facilitate learning in a number of different education environments. If we are to take the strategy of human investment and lifelong learning seriously, we need to recognise the complexity of human investment provision. This entails expanding the policies for human investment provision beyond the boundaries of institutionalised formal education, and examine how areas of life such as the workplace can become a place of learning. Indeed, it may be necessary to explore further what are the most suitable policies for the facilitation of learning in the non-formal and informal education environments. This was echoed in a recent review of national reports on the realisation of lifelong learning by the European Commission and Cedefop in which it was noted that "the potential for the workplace to be an inherently learning-oriented environment, rather than a place where theoretical knowledge is applied in practice" (European Commission and Cedefop, 2003:7) was an underdeveloped theme in need of further work.

Accordingly, it is possible to facilitate learning in a number of different education environments, and policies should be pursued which facilitate learning in all of these as appropriate. Policies aimed at increasing the level of human investment have a number of channels for achieving this objective. The conceptual framework establishes three different education environments of different relevance at two different periods of individuals' lives. This establishes a framework for understanding human investment, but also a framework informing policy makers of the various areas of possible intervention. All education environments and both periods are of relevance for the pursuit of increased human investment.

In addition, the policies need to acknowledge the unique nature of human investment provision within each education environment. The nature of the policies required to facilitate learning in the workplace for adults may thus be of a significantly different nature than the policies hitherto used to facilitate formal education and training. The different approaches to policies will reflect the different features highlighted in the specification of variables in chapter 4 and indicators presented in the scorecards in chapter 6.

This may appear a trivial point, but it deserves mention, since the implication of the argument is that the policies to increase human investment may encompass a wide range of policy areas not previously considered of relevance to the objective of investing in skills and abilities. This means considering the use of employment and industrial policy for the achievement of human investment objectives.

Moreover, in order to successfully facilitate learning in the different educational environments, it is important to recognise the several different stakeholders and actors involved in the processes of human investment. In period 1 this involves looking at formal institutions of education as organisations which need to adapt to new technologies and methods of learning, as well as ensuring the availability of ICT for the individual pupil. Training teachers in the use of ICT for education purposes may be as important as the actual introduction of ICT in schools. The introduction of new technologies does not in itself ensure the transformation of human investment processes in the formal education

environment, but requires significant efforts at the level of the organisation and individual. In period 2, policy makers need to recognise that the responsibility for human investment cannot be placed entirely on the individual learner. A critical part of realising the objective of lifelong learning is encouraging the facilitation of learning in the workplace. This requires efforts by both the individual employee and the organisation for which the individual is employed.

These different actors will face different incentives for and obstacles to human investment, and policy makers are faced with the challenge of accommodating the needs of all these actors to successfully facilitate human investment in the era of lifelong learning. For example, to facilitate learning in the non-formal education environment, it is necessary to pursue policies strengthening the opportunities for employees as well as employers in shaping learning opportunities. Moreover, in as so far as people need more education and training in period 2, policy interventions need to consider the particular obstacles and motivations for learning faced by adults. These may be obstacles associated with employment, family responsibilities etc. The extent to which different stakeholders will co-operate and participate in human investment provision will thus partly depend on the wider context, and how this context shapes incentives and obstacles. Accordingly, in some countries, the state will be seen as having primary responsibility for all human investment, while in other countries the responsibility for human investment in period 2 may lie with the individual learner or employers. An important implication from this argument is that countries may be pursuing different strategies for human investment provision.

The idea that countries may be pursuing different strategies in their efforts to facilitate lifelong learning gains further support from the findings from the analysis conducted in chapter 7. The analysis in chapter 7 attempts to deal with the more systemic differences between countries, and the results show that the role of different features of education environments in period 1, and notably the role of ICT and its interaction with the wider human investment framework, is different across countries in the European Union. This suggests that the policies pursued for human investment, and the successful introduction of ICT for human investment purposes, may differ between countries.

In addition, the analysis in chapter 7 suggests that for each factor of human investment, there are two different policy approaches. One is to introduce policies intended to increase the value of significant variables with positive coefficients from the analysis in chapter 7, or reduce the value of variables with negative coefficients. However, since the findings indicate differences between countries in the value and significance of the coefficients, chapter 7 suggests that the values and significance of the coefficients are by no means a given. Rather, differences between countries in the coefficients and interaction terms in chapter 7 are indicative of differences in processes within, outside or between education environments in which the resources specified in each of the variables are used. Such processes are as much subject to change through policy as the value of the specified variables themselves. Hence, by introducing the set of indicators in chapter 7, this project operationalises features of human investment provision in the member states of the European Union which opens up an array of areas for policy intervention. For example, policy makers faced with a relatively high influence of socio-economic background on education outcomes may ask whether there are processes of selection and exclusion in place in the education system that accentuates the influence of socio-economic status. Similarly, policymakers may be faced with interaction terms that suggest that the utilisation of ICT in the formal education environment increases the impact of various features of the informal education environment, such as socio-economic status, parental education or availability of ICT in the home. This raises questions as to the nature of the use of ICT, and whether there are measures that can support pupils from less advantaged backgrounds in making better use of ICT as a learning tool? In addition, the interaction terms for the ICT variables in the formal and informal education environment shows to what extent there are successful network effects resulting from ICT in the respective environments. Such network effects are indicative of the nature of ICT use in the two environments, and can be acted on by policymakers accordingly.

The coefficients and interaction terms thus also highlight areas of policy intervention. For example, successful intervention for the introduction of ICT in formal education can

affect the value of the relevant ICT indicator from the scorecards developed in chapter 6, or the value and significance of the relevant coefficients in the model developed in chapter 7. Both are important areas for policy intervention and this illustrates how the indicators developed in both chapters 6 and 7 are of relevance for successful policymaking. The risk associated with only using the indicators presented in chapter 6 is that critical areas of policy intervention are neglected. In as so far as indicators are intended to guide policy making and highlight areas of policy intervention, the complementary role of the indicators in chapters 6 and 7 is evident.

However, the existence of possible institutional and systemic differences also has a number of implications for policy learning between countries and the role of benchmarking. Hence, the issue of institutional differences does not only apply to the area of human investment, but to the use of benchmarking and the Open Method of Coordination more generally. The institutional differences will manifest themselves in a number of areas of the economy and society. The use of indicators to measure and benchmark the knowledge-based economy, as promulgated by the Lisbon Strategy, requires careful consideration of this matter. Instead of looking for a common set of indicators of equal relevance to all countries in the New Economy, we should be looking for indicators which cover and specify the different comparative advantages for each country within the New Economy. Since the New Economy is unlikely to emerge in a uniform manner for all EU member states the EU should play to its diversity and exploit the comparative advantages emerging for different member states in different stages and segments of the new waves of innovation. Furthermore, this argument resonates with the objective of the Open Method of Coordination to facilitate coordination rather than harmonisation. The role of benchmarking is thus not to promote harmonisation of human investment provision across the member states of the European Union, but to allow countries to exploit their particular strengths.

Indeed, the usefulness of benchmarking in policy areas with great structural differences and varied national traditions may be limited by the difficulties encountered in establishing common benchmarks as points of reference. This raises some serious

questions as to the possible scope and role of the Open Method of Coordination. For policy areas where national traditions and structural differences are more pronounced, it may prove difficult to reach agreement on a suitable set of indicators for benchmarking. The risk with simplified use of indicators is rushed conclusions that do not take account of contextual differences. Accordingly, successful policy learning will often require more than statistical indicators, and the need for learning practice should be explored further. The findings of this project thus lend support to the concerns on the use of benchmarks raised in much of the work analysing the implications of using the OMC as a tool for policy learning and discussed in the introduction of this thesis. As noted by De La Porte, Pochet and Room (2001:292), "benchmarking involves comparing how an organization is doing *relative* to its peers. It is therefore most obviously done by reference to organizations which have identical, or at least similar, objectives. However, even where the objectives are similar, benchmarking risks ignoring differences in the context of the organizations being compared. Lesson drawing based principally on benchmarking is therefore hazardous". Accordingly, De La Porte et al (2001) goes on to recommend a bottom-up approach to benchmarking in areas where no common objectives are feasible. This involves countries having considerable autonomy in defining their own benchmarks against which they believe they should be measured, and the European Commission having a coordinating role facilitating processes of learning rather than imposing benchmarks and targets from above. Moreover, "Coordination here must involve decentralized learning networks rather than hegemonic imposition of a monolithic discipline" (De La Porte et al, 2001:300). In light of the argument and findings presented in this project, it appears reasonable to allow for a significant amount of leverage to countries in their pursuit of lifelong learning, and make use of a bottom-up approach to benchmarking in the area of human investment. While there may be a consensus on the overall objective of increasing the level of human investment, the strategies and means by which this is achieved may vary greatly between countries. Indeed, the emergence of the more complex matrix of human investment provision associated with the paradigm of lifelong learning is likely to make the differences between countries more pronounced.

The nature of the OMC for different policy areas of the Lisbon Strategy may thus take different forms, depending on the extent to which common objectives can be agreed upon, and how pronounced differences in institutional framework and national traditions manifest themselves in a particular area of public policy. Hence, while this project provides a conceptual and operational framework for measuring and analysing human investment, the indicators chosen as benchmarks which countries should aspire to meet should in as far as possible be decided by each individual nation state.

However, it has also been noted in this project, that the information provided by the national and European Statistical System can play a significant role in guiding decision makers and stakeholders as to how relevant various features of the human investment framework are. Indeed, if a bottom-up approach to benchmarking is to be used for the area of human investment, such information may be as important as the benchmarks themselves. Accordingly, in recognition of possible differences in institutional frameworks in chapter 7, an operational framework for deciding what indicators from the scorecards were of particular relevance in different countries was developed. The arguments by De La Porte et al (2001) suggests that such analysis is a critical part of a comprehensive operationalisation of human investment for the purposes of the OMC and Lisbon Strategy. Implicit from the work in this project and the discussion about bottom-up approaches to benchmarking is thus that more sophisticated statistical information, such as that developed in chapter 7, and other data on differences in institutional frameworks and national traditions may be required for the successful use of the OMC in achieving the objectives of the Lisbon Strategy.

Accordingly, whilst the emphasis in this project has been to operationalise human investment in statistical indicators, it is also important to emphasise the limitations of statistical data for evidence based policymaking. As noted on several occasions in this thesis, there are significant methodological difficulties in measuring the complex processes of human investment. Such difficulties have been compounded by the emergence of lifelong learning as the paradigm of human investment provision. Indeed, for some of the dimensions of the human investment framework, notably the non-formal and informal education environments, the available data only provide us with a very

patchy picture of the human investment taking place. Consequently, we need to be careful that we, to use an old saying, do not value what we measure rather than measure what we value. For the purposes of policy learning and benchmarking we must thus be aware of the limitations of the available statistical indicators. This problem is increasingly being recognised, with BEEP (2003) noting that "Recent experience has shown that sole reliance on benchmarking tool (where cases are compared on the basis of their scores on a series of quantitative and qualitative indicators) is useful but limited. On their own, benchmarks and their concomitant identification of 'best practices' (i.e. those cases with the highest scores) can only take users so far. They do not easily take account of the different contexts and needs of users, not to mention the very different notions of 'best' and 'success' which different stakeholders may have" (BEEP, 2003:9). Rather, the introduction of indicators for benchmarking needs to be complemented with 'learning practice', "i.e. practices which achieve their own objectives and/or have a beneficial impact on their environment, and which provide useful learning experiences likely to stimulate creativity, ingenuity and self reflexivity on the part of the user of the case" (BEEP, 2003:9). This involves the inclusion of more qualitative information, such as case studies, allowing for a degree of contextualisation of the statistical indicators.

In conclusion, this project has argued that the transformations of human investment provision associated with the New Economy, introduces a more multi-dimensional human investment framework. The policy implications arising from these changes are manifold. In particular, there are a number of new areas for policy intervention. However, policymakers need to recognise that the different dimensions of the human investment framework contain different processes of human investment and therefore require different approaches to policy.

In addition, the findings in this project found great differences between countries in the various dimensions of the human investment framework. Moreover, the relative performance of countries is not uniform across dimensions. Different environments and features within each education environment take on different roles in different countries. In some countries formal education in period 1 will be dominant while in others there

may be relatively more human investment taking place in the non-formal dimension of period 2 etc.

It is suggested that the factors determining the different forms of lifelong learning are the incentives to the stakeholders in relation to the different dimensions of human investment. These incentives are in turn shaped by the wider institutional framework and political economic system. Hence, while lifelong learning is becoming the paradigm of human investment in the New Economy, countries will differ in their approach to establishing learning opportunities. Some types of skill provision are thus better suited for specific institutional and political economic contexts, and different configurations of the lifelong learning framework are likely to emerge across the EU.

The analysis conducted in this thesis also has wider implications for benchmarking and the Open Method of Coordination. The efforts to conceptualise and operationalise human investment has highlighted a number of methodological difficulties for successful benchmarking. Some of these difficulties apply to benchmarking more generally, and thus has implications for the success of the Open Method of Coordination. In particular, the analysis shows that it may be more appropriate to use a bottom-up approach to benchmarking, and that a more sophisticated approach to the use of indicators is required when extending benchmarking to areas where structural differences or different traditions between countries are more pronounced.

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